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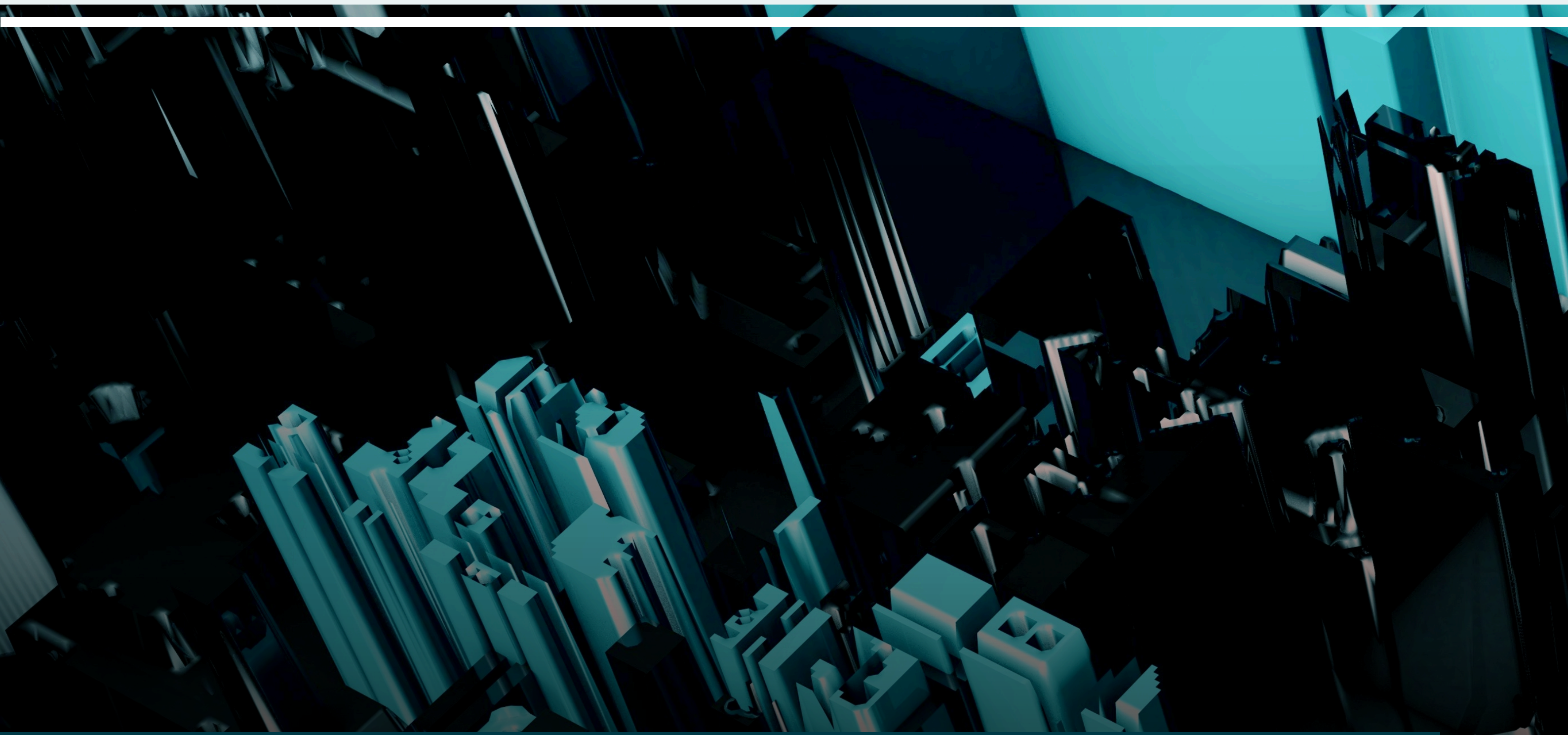

Indonesia's Semiconductor Industry

Towards Realising the Potential for Growth

Institute for Economics and Social Research
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ADAS	Advanced Driver-Assistance Systems
AI	Artificial Intelligent
ALD	Atomic Layer Deposition
AMD	Advanced Micro Devices
AMDAL	*Analisis Mengenai Dampak Lingkungan* (Environmental Impact Assessment)
ASEAN	Association of Southeast Asian Nations
ASML	Advanced Semiconductor Materials Lithography
AWR	Agriculture War Room
ASE	Advanced Semiconductor Engineering
ASU	Arizona State University
ATP	Assembly, Testing, and Packaging
BBNKB	*Bea Balik Nama Kendaraan Bermotor* (Motor Vehicle Title Transfer Fee)
BEV	Battery Electric Vehicle
BRICS	Brazil, Russia, India, China, South Africa
BWA	Broadband Wireless Access
CAD	Computer-Aided Design
CAGR	Compound Annual Growth Rate
CEIC	Census and Economic Information Centre
CHIPS	Creating Helpful Incentives to Produce Semiconductors for America
CIT	Corporate Income Tax
CSR	Corporate Social Responsibility
DRAM	Dynamic Random Access Memory
E&E	Electric and Electronics
e-KTP	*Kartu Tanda Penduduk Elektronik* (Electronic Resident Identity Card)
EDA	Electronic Design Automation
EDB	Economic Development Board
EFAS	External Factor Analysis Summary
ESDM	*Kementerian Energi dan Sumber Daya Mineral* (Ministry of Energy and Mineral Resources)
EV	Electric Vehicle
FDI	Foreign Direct Investment
FDR	Fluidised Bed Reactor
FTZ	Free Trade Zone
Gaikindo	*Gabungan Industri Kendaraan Bermotor Indonesia* (Indonesia Automotive Industries Association)

GDP	Gross Domestic Product
GSA	Global Semiconductor Alliance
Ha	Hectare
HEV	Hybrid Electric Vehicle
HS	Harmonised System
ICDeC	Indonesia Chip Design Collaborative Centre
ICEV	Internal Combustion Engine Vehicle
ICP-RIE	Inductively Coupled Plasma Reactive Ion Etching
IC	Integrated Circuits
IDM	Integrated Device Manufacturers
IFAS	Internal Factor Analysis Summary
IMEC	Interuniversity Microelectronics Centre
IoT	Internet of Things
IP	Intellectual Property
IPR	Intellectual Property Right
IT	Information and Technology
ITB	*Institut Teknologi Bandung*
ITERA	*Institut Teknologi Sumatera*
ITRI	Industrial Technology Research Institute
ITS	*Institut Teknologi Sepuluh November*
ITSI	International Technology Security and Innovation
IUP	*Izin Usaha Pertambangan* (Mining Business Licence)
KEK	*Kawasan Ekonomi Khusus* (Special Economic Zone)
KBLI	*Klasifikasi Baku Lapangan Usaha Indonesia* (Standard Classification of Indonesian Business Fields)
KTP	*Kartu Tanda Penduduk* (Resident Identity Card)
Lartas	*Larangan Terbatas*/Limited Prohibition
LCR	Local Content Requirements
LDWS	Laser Direct Write System
LEDs	Light-Emitting Diodes
LiDAR	Light Detection Ranging
LPDP	*Lembaga Pengelola Dana Pendidikan* (The Education Fund Management)
LSTC	Leading-Edge Semiconductor Technology Centre
MAP	Microprocessor Applications Project
MEMS	Micro-Electro-Mechanical System

MIC	Made in China
MIMOS	Malaysian Institute of Microelectronic Systems
MISS	Microelectronics Industry Support Scheme
MITI	Ministry of International Trade and Industry
Mm	Millimetre
MoU	Memorandum of Understanding
MPW	Multi Project Wafer
NAPMP	National Advanced Packaging Manufacturing Programme
NEB	National Enterprise Board
NGO	Non-Governmental Organisation
Nm	Nanometre
NSS	National Semiconductor Strategy
NSSTF	National Semiconductor Strategy Task Force
NSTC	National Semiconductor Technology Centre
NTU	Nanyang Technological University
O	Opportunity
ODM	Original Equipment Manufacturer
OECD	*Organisation for Economic Co-operation and Development*
OEM	Original Equipment Manufacturer
OHS	Occupational Health and Safety
OREI	*Orgaisasi Elektronik dan Informatik* (Organisation of Electronics and Informatics Research)
OSH	Occupational Safety and Health
OSS	Online Single Submission
OSAT	Outsourced Semiconductor Assembly and Test
PCB	Printed Circuit Boards
PCBA	Printed Circuit Boards Assemblies
PECVD	Plasma Enhanced Chemical Vapor Deposition System
PESTEL	Politic, Economic, Social, Technology, Environment, Legal
PKB	*Pajak Kendaraan Bermotor*/Motor Vehicle Tax
PCB	Printed Circuit Boards
PCBA	Printed Circuit Boards Assemblies
PECVD	Plasma Enhanced Chemical Vapor Deposition System
PESTEL	Politic, Economic, Social, Technology, Environment, Legal
PKB	*Pajak Kendaraan Bermotor*/Motor Vehicle Tax
PNRI	*Percetakan Negara Republik Indonesia* (State Printing Company of the Republic of Indonesia)

PPISI	Perhimpunan Praktisi Industri Semikonduktor Indonesia (Indonesian Semiconductor Industry Practitioners Association)
PPnBM	*Pajak Penjualan atas Barang Mewah* (Luxury Goods Sales Tax)
PT	*Perseroan Terbatas* (Limited Liability Company)
R&D	Research and Development
RF	Radio Frequency
RFID	Radio Frequency Identification
RIIM	*Riset Inovasi untuk Indonesia Maju* (Research and Innovation for an Advanced Indonesia)
RISC-V	Reduced Instruction Set Computing - Version 5
RPJMN	*Rencana Pembangunan Jangka Menengah dan Panjang* (Medium- and Long-Term Development Plan)
RTA	Rapid Thermal Annealing (RTA)
S	Strength
Satgas Semikonduktor	the Semiconductor Ecosystem Task Force
SCPA	Semiconductor Chip Protection Act
SGS	Semiconductor Industry Association
SIA	Intellectual Property Right
SIP Core	Semiconductor Intellectual Property Core
SKKNI	*Standar Kompetensi Kerja Nasional Indonesia* (Indonesian National Work Competency Standards)
SMART USA	Semiconductor Manufacturing and Advanced Research with Twins USA
SMEs	Small and Medium-Sized Enterprises
SMK	*Sekolah Menengah Kejuruan* (Vocational High Schools)
SoC	System on Chip
SSIA	Singapore Semiconductor Industry Association
STEM	Science and Technology Parks
STP	Science and Technology Parks
SWOT	Strength, Weakness, Opportunity, Threat
T	Threat
TKDN	*Tingkat Komponen Dalam Negeri* / Domestic component level
TSMC	Taiwan Semiconductor Manufacturing Company
UGM	*Universitas Gadjah Mada*
UI	*Universitas Indonesia*
UK	United Kingdom

UNAND	*Universitas Andalas*
UNDIP	*Universitas Diponegoro*
UNRAM	*Universitas Mataram*
UNIDO	the United Nations Industrial Development Organisation
UMC	United Microelectronic Corporation
UTI	Uni Traktor Indonesia
UV Vis	Ultraviolet Visible Spectroscopy
VAT	Value Added Tax
W	Weakness
WSC	World Semiconductor Council
XRD	X-ray Diffraction

EXECUTIVE SUMMARY

Indonesia's Semiconductor Industry: Towards Realising the Potential for Growth

The global semiconductor industry is valued at over USD 600 billion and is driven by the increasing digitalisation of economies, rising demand for computing and communication devices, the electrification of transport, and the adoption of smart technologies. The industry is concentrated among key players, such as the United States, Taiwan, South Korea, China, and Japan, who dominate large-scale manufacturing and fabrication. While not a manufacturing powerhouse, the United Kingdom (the UK) plays a strategic role in chip design, compound semiconductors, and research and innovation. As supply chains diversify, new manufacturing and design hubs are emerging in Southeast Asia, offering strategic opportunities for countries like Indonesia.

Indonesia's semiconductor industry is currently at a nascent stage and contributes to 0.24% of global semiconductor revenues. Indonesia's activities are presently focused on downstream processes, such as assembly, testing, and packaging (ATP)[1], with a growing presence in integrated circuit (IC) design[2]. The country is well-positioned to expand upstream, given its rich reserves of key raw materials and its strategic location between the Indian and Pacific Oceans. A well-developed semiconductor sector would not only boost economic growth, but also advance Indonesia's technological independence, support skilled employment, and position the country more firmly within critical global value chains.

This study aims to identify Indonesia's current position within the semiconductor value chain, assess key opportunities and barriers, and propose actionable recommendations for stakeholders. The research draws on desk reviews, key informant interviews, and a multi-stakeholder consultative workshop. The findings offer a roadmap for positioning Indonesia as a future semiconductor hub in the region.

Indonesia's Strategic Advantages in Semiconductor Development

Indonesia possesses several key advantages that position it to build a competitive and resilient semiconductor industry.

1. **Abundant natural resources for upstream development:** Indonesia is rich in key semiconductor raw materials, such as silica sand, tin, bauxite, nickel, cobalt, gallium, and germanium. These resources, if processed to high-purity standards, can reduce import dependency and position Indonesia as a regional supplier for semiconductor materials.

2. **Strategic geographic position in the Indo-Pacific:** Indonesia's location between the Indian and Pacific Oceans and near global semiconductor hubs like China and Taiwan makes it an attractive candidate for regional integration and export-oriented supply chains

1 The assembly, testing, and packaging (ATP) process, also referred to as back-end semiconductor manufacturing, includes dividing wafers into individual chips, packaging chips into frames or resin shells, and conducting testing

2 The design process sets the chip's requirements, defines its architecture, and validates the design using a test bench

3. **Expanding domestic demand, broad sectoral applications, and global diversification momentum:** Indonesia's semiconductor demand is driven by strong growth in electronics, automotive (particularly electric and hybrid vehicles), finance, agriculture, healthcare, and public services. The consumer electronics market alone is projected to grow from USD 18.98 billion in 2025 to USD 20.69 billion in 2029, supported by rising demand for smart devices. Meanwhile, EV production surged over 500% annually between 2020–2023, with government-backed incentives further boosting adoption. Simultaneously, global semiconductor firms are seeking to diversify their supply chains away from traditional hubs like China and Taiwan. Indonesia's untapped potential and improving investment climate position it as a strategic destination for such realignments.

4. **Government initiatives and international partnerships:** Programs such as Making Indonesia 4.0 and the formation of the Semiconductor Ecosystem Task Force reflect growing national commitment. Partnerships with institutions like IMEC (Belgium) and Singapore-based chip design firms are beginning to build technical capacity.

5. **Potential to become an electronic vehicle (EV) manufacturing hub:** With battery electric vehicles (BEV) and hybrid electric vehicles (HEV) production growing exponentially, BEVs rising from 153 units in 2020 to 15,318 in 2023, Indonesia's EV push is set to increase demand for advanced semiconductors for use in battery management systems and advanced driver-assistance systems (ADAS) components.

Key Challenges

Despite the promising opportunities, Indonesia faces several challenges that could hinder the growth and competitiveness of its semiconductor industry.

1. **Policy and regulatory challenges: Indonesia lacks a cohesive, long-term national strategy for the semiconductor sector, resulting in fragmented progress across investment, talent development, research, and infrastructure.** Regulatory frameworks, particularly those governing foreign direct investment and tax incentives, remain underdeveloped, weakening Indonesia's competitiveness compared to regional peers such as Malaysia and Vietnam. Complicated and inefficient import-export procedures, including slow customs clearance and limited technical expertise among officials, frequently delay the movement of critical materials and components essential for semiconductor manufacturing. Additionally, the absence of structured knowledge transfer mechanisms and weak intellectual property protections hamper local capability building and deter meaningful foreign collaboration.

2. **Human capital challenges: A critical barrier to Indonesia's semiconductor development is the shortage of skilled professionals across the value chain.** Despite ongoing initiatives, the country faces persistent gaps in education, practical training, and industry-academia collaboration. The limited number of engineers, weak alignment between university curricula and industry needs, and insufficient exposure to industry-standard tools have left graduates underprepared for semiconductor roles. Initiatives like Indonesia Chip Design Collaborative Centre (ICDeC) have made strides in training and software access but remain constrained by limited funding and institutional support. High licensing costs, lack of standardised certification, and minimal government investment further hinder talent development. Meanwhile, brain drain and uncompetitive career prospects continue to drive top engineering graduates to countries such as Taiwan, China, and Malaysia, intensifying the challenge of building a robust domestic talent pipeline.

3. **Infrastructure challenges: Indonesia's infrastructure presents several challenges for semiconductor development, particularly the lack of advanced technology and the limited reliability of its industrial zones.** While the country has abundant raw materials like silica sand, it lacks the technology to process them to the purity levels required, resulting in continued import dependence. Many industrial zones are not yet equipped with reliable electricity, clean water, or effective waste management, key requirements for semiconductor manufacturing. High utility costs also hinder industry growth and innovation. Additionally, the low adoption of renewable energy in industrial zones poses a barrier to developing environmentally sustainable semiconductor facilities.

4. **Research & development and commercialisation challenges: Indonesia's underdeveloped innovation ecosystem, characterised by limited IP capacity, high R&D costs, weak academia-industry links, and lack of commercialisation support, undermines local semiconductor development.** The lack of domestic intellectual property (IP) firms has made Indonesia heavily dependent on foreign licenses, limiting local value capture and technological autonomy. R&D efforts are constrained by high software costs, limited funding, and the absence of meaningful tax incentives. Collaboration between academia, industry, and government is often hindered by bureaucratic obstacles and the lack of a structured technology transfer framework. The broader innovation ecosystem remains underdeveloped, with inadequate research funding, weak support for startups, and limited academia-industry synergy. Moreover, local semiconductor designs face significant commercialisation barriers due to reliance on overseas facilities for fabrication and testing, increasing both costs and time to market.

Recommendations

To address the key challenges facing Indonesia's semiconductor industry, a series of strategic actions are recommended. These actions focus on policy, human capital development, infrastructure enhancement, and research and development. These recommendations are to be implemented in collaboration with key stakeholders, including the government, private sector, educational institutions, and international partners.

1. **Policy and regulatory frameworks**
   Develop and implement a national semiconductor strategy with clear investment and regulatory reforms. Indonesia needs a cohesive national strategy for the semiconductor industry, coordinated across ministries and institutions. This strategy should build on the work of the Semiconductor Ecosystem Task Force and set clear directions for investment, technology development, workforce readiness, and infrastructure. Regulatory clarity, especially around foreign direct investment (FDI) screening, and consistent incentives, such as stable and long-term tax holidays, R&D tax allowances, and import duty exemptions, are essential to improve investor confidence. Benchmarking international best practices, such as the UK's National Semiconductor Strategy (2023) or Malaysia's National Semiconductor Strategy (2024), can help Indonesia streamline investment processes, strengthen FDI governance, and promote trade and knowledge transfer to accelerate ecosystem development.

2. **Human capital and talent development**
   Strengthen semiconductor workforce through industry-aligned education and practical training. Indonesia needs to develop national competency standards tailored to semiconductor industry needs. Education and training programmess, both at vocational and university levels, should be revised to include more hands-on, industry-relevant content. This includes specialised training in IC design, semiconductor fabrication, and packaging technologies. Partnerships with the private sector, international institutions, and initiatives focused on microelectronics and chip design. Expanding access to essential learning tools, such as subsidised design software, cleanroom facilities, and lab infrastructure, will also be key. Stronger collaboration between academia and industry is necessary to ensure graduates are job-ready and to improve long-term talent retention in the sector.

3. **Infrastructure development**
   Upgrade industrial zones and upstream processing to support semiconductor manufacturing. Indonesia needs to enhance infrastructure readiness in key Special Economic Zones (SEZs), particularly KEK Tanjung Sauh and KEK Nongsa, by ensuring reliable electricity, clean water supply, and efficient waste management[3]. These facilities are essential to meet the stringent environmental and technical requirements of semiconductor manufacturing. In parallel, investments are needed to process critical raw materials, such as silica, gallium, and germanium, into high-purity inputs domestically, reducing reliance on imports and strengthening the resilience of Indonesia's supply chain. To support this, Indonesia should mobilise financing from multiple sources, including public-private partnerships (PPP), sovereign wealth funds (SWF), and other innovative financing mechanisms, to accelerate the development of supporting infrastructure, including manufacturing facilities and research centres.

4. **Research, development, and commercialisation**
   Establish integrated R&D hubs and reduce barriers to semiconductor innovation. Indonesia needs to strengthen its innovation ecosystem by developing research and development hubs that connect universities, start-ups, and industry players. These hubs should receive government support, including matching grants and co-financing schemes to support prototype development and the commercialisation of intellectual property (IP). Reducing structural barriers, such as high costs for chip design software and limited access to fabrication infrastructure, will be essential for enabling local innovation. Closer collaboration among academia, government, and the private sector is also needed to improve research quality and accelerate the translation of innovation into commercially viable products. Examples include the Indonesia Chip Design Collaborative Centre (ICDeC), which brings together 13 universities, including Universitas Indonesia (UI), Institut Teknologi Bandung (ITB), Universitas Gadjah Mada (UGM), and Institut Teknologi Sepuluh Nopember (ITS), with industry players like PT Xirka Silicon Technology and Versatile Systems and Technologies to support IC design and talent development.

3 Special Economic Zones (SEZs) in Indonesia are coordinated by the National Council for Special Economic Zones (*Dewan Nasional KEK*), chaired by the Coordinating Minister for Economic Affairs (*Kementerian Koordinator Bidang Perekonomian*). The council sets national policy, approves proposals, and oversees implementation across ministries and regions. At the local level, each SEZ is managed by an SEZ Administrator (*Administrator KEK*), appointed by regional governments and responsible for permits, investor services, and operational management. Regional governments also support infrastructure development and facilitate coordination with the central government. The Ministry of National Development Planning (*Kementerian Perencanaan Pembangunan Nasional/Bappenas*), the Ministry of Industry (*Kementerian Perindustrian*), the Ministry of Tourism and Creative Economy (*Kementerian Pariwisata dan Ekonomi Kreatif*), the Ministry of Finance (*Kementerian Keuangan*), and the Ministry of Investment (*Kementerian Investasi/BKPM*) are involved in providing sectoral policy guidance, fiscal incentives, and investment facilitation, depending on the SEZ's focus.

5. **Innovation ecosystem and international collaboration**
   Strengthen global partnerships to support strategy design, skills development, and technology transfer. Strategic international collaboration will be important in accelerating Indonesia's semiconductor ambitions. Countries such as the United Kingdom can collaborate on national strategy formulation, regulatory design, and investment screening frameworks by sharing relevant policy experience. In addition, international partnerships can facilitate on-the-job training, academic exchanges, and joint research initiatives. **Collaborations with world-class universities and R&D institutions, including the University of Oxford, the University of Cambridge, and Imperial College London, will help build Indonesia's human capital and research capacity.** Aligning intellectual property protections and investment standards with international norms will also strengthen investor confidence and support long-term cooperation.

Collaboration Opportunities for Indonesia and the UK in Semiconductor Development

The United Kingdom's strengths in chip design, compound semiconductors, and policy development present opportunities for collaboration with Indonesia across strategic areas. For the UK, working with Indonesia presents a strategic opportunity to access Southeast Asia's rapidly growing markets, particularly in electronics, EVs, and digital infrastructure. It opens new commercial pathways for UK firms in chip design and IP, while diversifying global R&D partnerships and strengthening supply chain resilience. Additionally, it reinforces the UK's leadership in global science governance through contributions to international standards and regulation and deepens talent and education ties via joint training and academic exchange initiatives. These initiatives would foster a supportive ecosystem for sustained innovation. Both countries stand to gain: Indonesia can fast-track its industrial capability and reduce external dependence, while the UK strengthens its strategic engagement in Southeast Asia and forges new academic and commercial connections in a rapidly expanding market.

The recommendations for collaboration between Indonesia and the UK may include the following priorities.

1. **The United Kingdom and Indonesia could strengthen its bilateral cooperation to shape Indonesia's semiconductor policy and regulatory frameworks.** Drawing on the UK's National Semiconductor Strategy (2023), this collaboration could focus on supporting Indonesia's long-term roadmap, streamlining investment procedures, improving FDI screening mechanisms, facilitating trade and knowledge transfer processes, and promoting knowledge exchange and capacity-building initiatives to accelerate ecosystem development. For the UK, this collaboration reinforces its thought leadership in global semiconductor governance, expands its influence in shaping emerging market regulatory models, and strengthens its strategic presence in Southeast Asia, a region critical to global supply chain resilience.
2. **In human capital development, joint efforts may encompass support in curriculum design, set up of vocational trainings, academic exchanges, scholarships, and placements within UK-based semiconductor firms (e.g., Arm, Pragmatic Semiconductor, and Dialog Semiconductor) to strengthen Indonesia's chip design and engineering workforce.** Academic collaboration can be strengthened between the UK's academic institutions which offer programmes in compound semiconductors and microelectronics (e.g., Cardiff University, University of Bristol, and Swansea University) and Indonesia's universities which have been focused in these areas (ITB, UI, UGM, Universitas Diponegoro, ITS). These initiatives aim to build a strong pipeline of Indonesian talent in

semiconductor-related disciplines, particularly in chip design, while fostering long-term institutional ties between the two countries. For the UK, this collaboration may expand the international footprint of its firms and universities, enhance their relevance in Southeast Asia's innovation landscape, and strengthen the UK's position as a global leader in semiconductor education, talent development, and commercial engagement.

3. **Joint efforts in research and innovation can focus on strengthening Indonesia's chip design ecosystem.** Building on the UK's strengths in compound semiconductors, IP commercialisation, and public–private R&D funding, collaboration may include the establishment of joint design hubs, shared access to design tools, and co-funded research initiatives to scale Indonesia's innovation capacity and lower entry barriers for local semiconductor firms. Research collaboration can also leverage existing frameworks (e.g., the Newton Fund, the Global Challenges Research Fund, and Innovate UK), partnered with several domestic institutions which have been focused on chip design (e.g., ITB, UI, ICDeC). Research collaboration may also involve the UK's leading institution (e.g., University of Oxford, University of Cambridge, and Imperial College London). For the UK, this collaboration offers a platform to pilot frontier technologies in emerging markets, broaden the application of UK-generated IP, and amplify the global impact of its research funding by aligning with Indonesia's fast-growing innovation ecosystem.

4. **Industrial and infrastructure collaboration may focus on advancing labour-intensive semiconductor segments in Indonesia, such as wafer fabrication and assembly, testing, and packaging (ATP).** The UK's expertise in sustainable industrial zone planning is particularly relevant for Indonesia's Special Economic Zones (SEZs), where partnership opportunities exist in clean energy, utilities, and high-tech infrastructure investment. This collaboration may strengthen the UK's role in chip manufacturing.

5. **Further engagement in cybersecurity, IP regulation, and open data standards can support Indonesia's alignment with international norms and enhance the overall resilience of its semiconductor ecosystem.** Deeper cooperation between universities, research institutions, and industries from both countries will be critical in ensuring a secure and innovation-driven future. This collaboration may create potential opportunities to internationalise the UK's digital standards and digital infrastructure, which may expand its influence in terms of technology governance.

CHAPTER 1

Introduction

The semiconductor industry plays a key role in modern technological development and economic growth. As a critical component in various sectors, including telecommunications, computing, automotive, and industrial automation, semiconductors have become indispensable to global supply chains. The industry's growth has been shaped by rapid technological advancements, increasing digitalisation, and increasing demand for electronic goods.

Indonesia, with its resource endowments and strategic location in Southeast Asia, has the potential to expand its role in the semiconductor industry. The country's industrial development agenda, focus on technological advancement, and participation in global supply chains present opportunities for further integration into the sector. At the same time, various structural and policy-related factors influence the extent to which Indonesia can enhance its competitiveness in semiconductor manufacturing and related activities.

Against this backdrop, this study seeks to identify key factors, challenges, and opportunities for the development of Indonesia's semiconductor industry. Through an analysis of industry dynamics, policy considerations, and economic conditions, the study aims to provide insights that can inform strategies for strengthening Indonesia's position in the global semiconductor value chain.

1.1. Scope of the Study and Research Methodology

This study explored the key factors, challenges, and opportunities shaping the growth of Indonesia's semiconductor industry and provides actionable recommendations to enhance its global competitiveness. It included a comprehensive landscape analysis of the semiconductor ecosystem, covering demand and supply-side dynamics, key stakeholders, regulatory frameworks, and Indonesia's comparative advantages. The study also assessed the industry's integration into global semiconductor value chains to identify strategic pathways for sustainable growth. In addition, a foresight analysis was conducted to examine critical challenges, emerging trends, and future opportunities over the next 5 to 10 years. This analyses included identifying potential growth drivers, global best practices, and strategic initiatives that could strengthen Indonesia's position in semiconductor manufacturing and innovation.

The research questions guiding each work package and their corresponding report chapters are outlined in Annex A.

1.2. Methodology

This study employed following **research methods** to address the research questions:

1. **Desk review:** The literature review covered academic and industry sources on semiconductor technology, economic impact, and global supply chains. Data from Trade Map, UN Comtrade, Statista, and Statistics Indonesia (BPS) were analysed to identify trends in trade, production, and GDP contribution. A comparative analysis examined policies and incentives in China, the European Union, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand, the United Kingdom, the United States, and Vietnam, focusing on government support, infrastructure, research and development, and raw material sourcing.

2. **Key Informant Interviews (KIIs):** Semi-structured interviews were conducted with industry experts, policymakers, corporate leaders, research centres and technical specialists (see Annex B and C) to gather views on regulation, market dynamics and strategic challenges. Among them, three industry experts (see Annex B) were specifically interviewed to clarify definitions, map key applications and stakeholders, and explore challenges, opportunities, and policy settings. These findings were cross-examined against the desk research to ensure consistency and reliability.

3. **Consultative workshops:** A two-days workshop was organised with the participation of 23 representatives from government, industry, academia and associations (see Annex D) to validate early insights and gather feedback. The research team facilitated PESTEL and market trend analysis and SWOT exercises to identify strategic actions and inform recommendations.

CHAPTER 2

Semiconductor Industry Structure and Global Production Value Chain

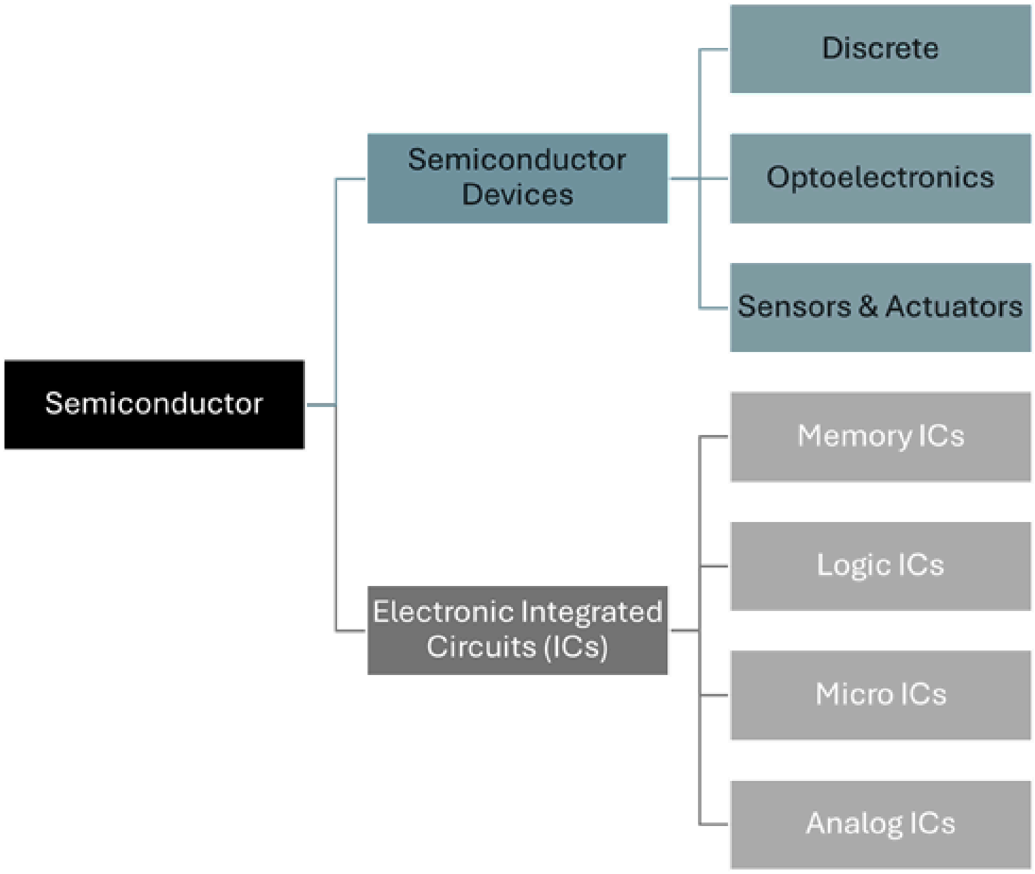
Semiconductor technologies broadly cover semiconductor devices and electronic integrated circuits (ICs). Semiconductor devices are discrete components that are typically used as building blocks for larger electronic ecosystems, while ICs are complex semiconductors consisting of multiple semiconductor devices, typically packaged into a single chip to perform specific functions. The production process for semiconductors consists of three main steps: design, fabrication, and assembly, testing, and packaging. Some semiconductor companies, called Integrated Device Manufacturers (IDMs), handle all three production steps, while fabless, foundries, and OSAT specialise in specific stages. The ecosystem also relies on supporting activities, including EDA (Electronic Design Automation) and SIP (Semiconductor Intellectual Properties) Cores, material processing, and equipment providers. Broadly, upstream production refers to raw materials processing and IC design, midstream production includes wafer fabrication, and downstream production covers Assembly, Testing, and Packaging (ATP).

The semiconductor industry is a growing global sector, driven by rising demand for electronic devices and technological advancements across industries such as automotive, telecommunications, healthcare, and finance. As supply chains diversify beyond the US, China, and Taiwan, Southeast Asian nations like Singapore, Malaysia, Vietnam, and Thailand have gained prominence, with Indonesia also holding potential for integration into the global semiconductor value chain. To establish context, this chapter will first explain semiconductor technologies, the production process, and Indonesia's current semiconductor ecosystem landscape.

2.1. Definition and Type of Semiconductor

A **semiconductor** is defined as a material with electrical conductivity that falls between that of an insulator and a conductor, making it controllable for various electronic applications [1], [2]. **In general, semiconductors can be classified into two major categories: Semiconductor Devices and Electronic Integrated Circuits** (See Figure 2.1).

FIGURE 2.1. Types of Semiconductors



Source: Adapted from Kleinhans & Baisakova (2020) and Statista (2024)

Semiconductor Devices focus on basic, discrete components that are typically used as building blocks for larger electronic ecosystems. It functions to transmit, receive, and transform information related to continuous parameters, such as temperature and voltage[3]. These devices are further divided into three main categories: Discretes, Optoelectronics, and Sensors & Actuators [4], [5]:

- **Discrete Semiconductors,** such as transistors, have basic functions and are used alongside other semiconductors in various applications.
- **Optoelectronics,** such as Light-Emitting Diodes (LEDs), function in light processing and control.
- **Sensors & Actuators,** such as gyroscopes and MEMS mirrors, serve two primary purposes: detecting changes and/or triggering actions.

Meanwhile, **Electronic Integrated Circuits (ICs) usually serve as the “brains” of electronic systems.** They are complex semiconductors consisting of multiple semiconductor devices, typically packaged into a single chip to perform specific functions. Based on these functions, ICs are categorised into Memory ICs, Logic ICs, Micro ICs, and Analog ICs [4], [5]:

- **Memory ICs** store data, with DRAM serving as temporary storage for computing processes and NAND as long-term storage in many modern devices.

- **Logic ICs** handle digital logic operations within electronic systems.
- **Micro ICs,** such as microprocessors and microcontrollers, function as processing units in smart devices.
- **Analog ICs** interact with the physical world by converting or generating signals, such as electricity, radio waves, or light.

Semiconductor devices generally have lower value-added than integrated circuits, as they are simpler, unassembled components rather than fully integrated and complex semiconductor systems. However, together with integrated circuits, they form the foundation of modern electronics, driving advancements across industries.

2.2. Production Process and Value Chains

The production process for semiconductors consists of three main steps: design, fabrication, and assembly, testing, and packaging [4]:

- The **design process** sets the chip's requirements, defines its architecture, and validates the design using a test bench.
- The **fabrication process**, also known as **front-end semiconductor manufacturing,** involves wafer fabrication, which includes printing (etching) the integrated circuit onto the wafer and depends on many complex manufacturing processes.
- The **assembly, testing, and packaging (ATP) process,** also referred to as **back-end semiconductor manufacturing**, includes dividing wafers into individual chips, packaging chips into frames or resin shells, and conducting testing.

In practice, **some semiconductor companies handle all three production steps, while others focus solely on a single step.** Companies that cover the entire process are known as **Integrated Device Manufacturers (IDMs)** [4]. Meanwhile:

- **Fabless** are companies that specialise in chip design.
- **Foundries** are fabrication companies that manufacture the chips in their own facilities. Fabless companies typically rely on contracts with foundries.
- Outsourced Semiconductor Assembly and Test (OSAT) companies handle the ATP process if foundries do not conduct it in-house

However, the design, fabrication, and ATP processes cannot operate without supporting industries. Supporting industries in semiconductor production include [4]:

- Electronic Design Automation (EDA) and Semiconductor Intellectual Property (IP) Cores, which support the design process. EDA refers to software tools used for designing ICs and PCBs, while IP Cores are reusable units or layouts that can be licensed or owned exclusively. The design process heavily relied on both.
- **Upstream semiconductor process,** includes **material processing** that provides key raw materials for fabrication and ATP and **IC design** that sets the blueprint for fabrication.
- **Midstream semiconductor process** covers **wafer fabrication** that transforms design files into physical chips on wafers.

- **Downstream semiconductor process** consists of **Assembly, Testing, and Packaging (ATP)** that ensures quality and functionality before the chips are delivered to end users.
- **Semiconductor equipment providers**, supply specialised semiconductor equipment for every stage of semiconductor production.

The semiconductor production process is highly complex and globally distributed. Wafer fabrication might take place in Europe, while the backend process is often handled in Asia, such as Malaysia. Final testing can also be conducted in Malaysia before the chips are sold to markets in the US, Europe, or China. EDA, materials, and equipment are also sourced globally, with major suppliers based in the US, Europe, and Asia. As a result, producing a single semiconductor involves multiple countries, and it is rare for the entire semiconductor production process to be carried out within just one country. Examples of global companies involved in semiconductor production and the value chain can be found in Box C.

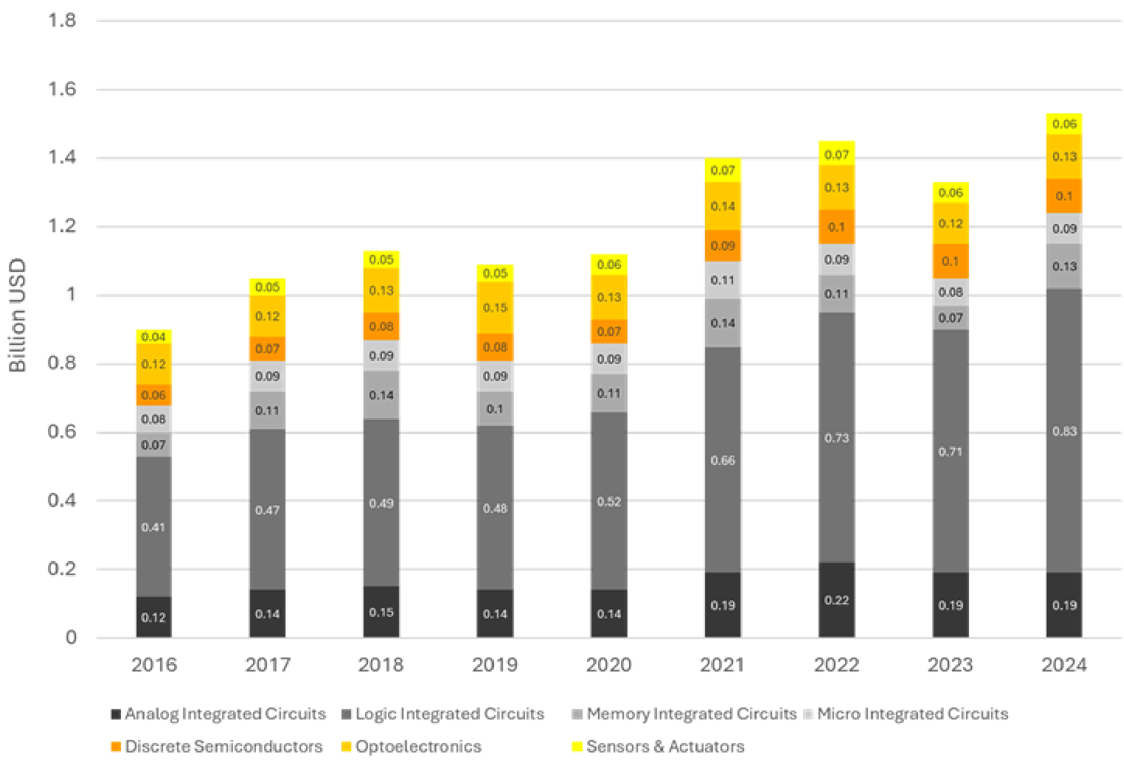
CHAPTER 3

Overview of Indonesia's Semiconductor Ecosystem

Indonesia holds a small but growing 0.24% share in the global revenue, mainly derived from imports of semiconductor devices and ICs rather than domestic manufacturing. While the country is active in ATP and IC design, it lags behind other Southeast Asian countries in key areas such as fabrication and materials processing, limiting its role to downstream activities. Recognising the importance of semiconductors, in 2023, the country has made priority under Asta Cita and Making Indonesia 4.0, establishing the Semiconductor Ecosystem Task Force. The task force is responsible for developing a national semiconductor ecosystem through coordinating cross-sector policies and strengthening collaboration between key stakeholders.

Indonesia holds a small but growing share of the global semiconductor revenue, contributing 0.24% of global revenue. In 2024, the global revenue of the semiconductor industry was USD 626.9 billion, with Indonesia's total revenue from the semiconductor market being USD 1.54 billion (Figure 3.1). Out of the USD 1.54 billion, USD 1.25 billion came from IC-type semiconductors. However, this still marks an increase, as Indonesia's semiconductor market revenue was only USD 0.90 billion in 2016, with the highest growth recorded in 2021 due to the pandemic and the surge in digital technology adoption.

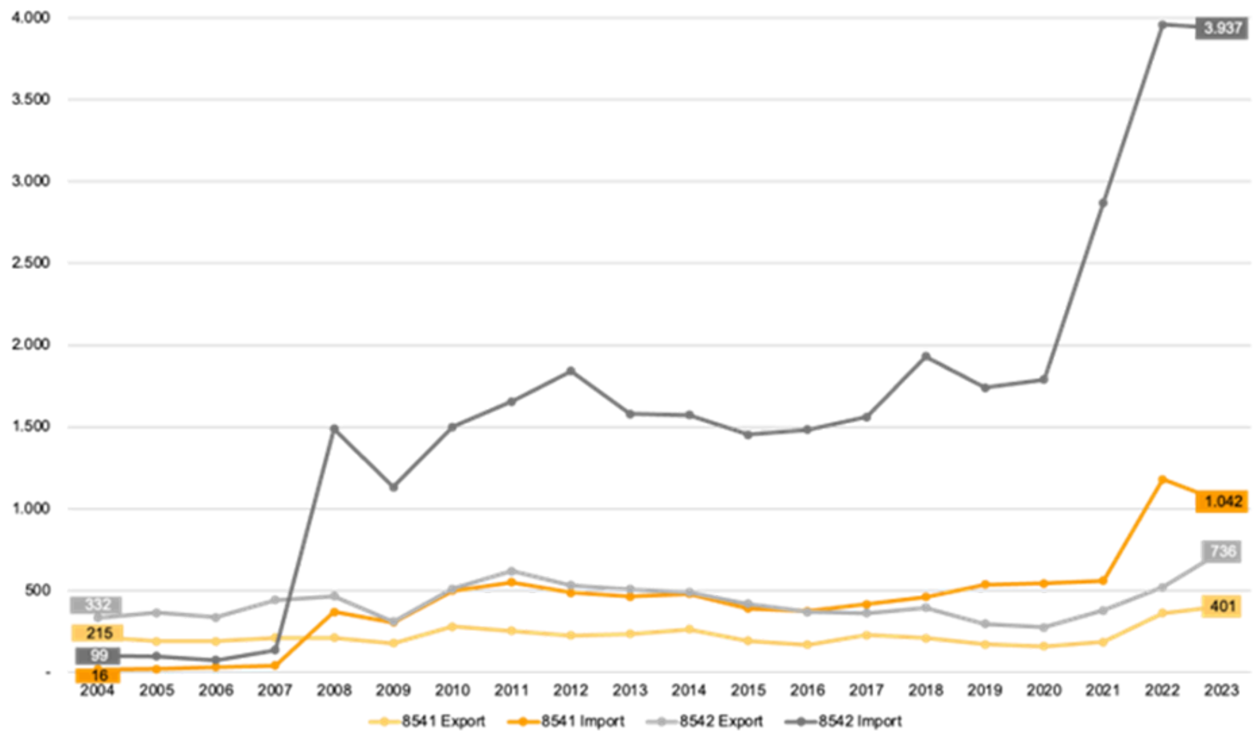
FIGURE 3.1. **Indonesia's Semiconductor Revenue 2016 - 2024 (in Billion USD)**



Source: Statista (2024)

Figure 3.2 represents semiconductor sales in Indonesia than domestic production, reflecting an increase in imported semiconductors rather than locally manufactured ones. In terms of trade, Indonesia exported USD 401 million worth of semiconductor devices and USD 736 million in ICs. However, imports far exceeded exports, amounting to USD 1.04 billion for semiconductor devices and USD 3.94 billion for ICs indicating high domestic demand.

FIGURE 3.2. **Indonesia's Export and Import of Semiconductor Devices (HS 8541) and Electronic Integrated Circuits (HS 8542) (Nominal Value in Million USD)**



Source: CEIC (2024)

This reliance on imported semiconductors is also reflected in Indonesia's limited role in manufacturing, despite its growing involvement in ATP and IC design. Currently, ATP is the primary area of domestic production, with Infineon Technologies Batam (see Box B) as the only company operating in this segment, exporting 100% of its output. As a result, Indonesia's semiconductor exports are almost entirely dependent on this single company. In chip design, Indonesia has a few fabless companies[4] [6]. Meanwhile, in fabrication and materials processing, Indonesia lacks foundries and does not yet have the material processing technologies needed for semiconductor production. The absence of domestic wafer fabrication and chip design capabilities has left Indonesia entirely dependent on imported semiconductor components for ATP processes. Consequently, the country functions as a downstream player in the global semiconductor value chain rather than a full-scale manufacturing hub.

Indonesia's small role in the global value chain is partly due to missed opportunities in the 1970s however it has become a national government priority. At the time, the country had a chance to establish its semiconductor industry, but differing policy strategies and vision led this opportunity to be taken up by other nations and the country remained largely absent from the early development of the global semiconductor supply chain. However, decades later, interest in the semiconductor sector has resurged and it has become a government priority under Asta Cita

4 A fabless company specialises in the design and development of semiconductor chips without engaging in in-house manufacturing.

and Making Indonesia 4.0. Public and private sectors have intensified efforts through bilateral negotiations, industry associations, and research initiatives to develop Indonesia's semiconductor industry. This renewed focus highlights the growing recognition of semiconductors as a strategic industry and the need to build domestic capabilities to reduce import reliance.

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The government has established the Semiconductor Ecosystem Task Force (Satgas Semikonduktor) to develop a national semiconductor strategy [7]. The task force is responsible for coordinating cross-sector policies related to investment, technology, labour, and semiconductor manufacturing infrastructure. Its role is expected to enhance synergy between government, industry, and academia to strengthen Indonesia's semiconductor supply chain. It also plays a key role in developing a roadmap to boost Indonesia's competitiveness, particularly in attracting foreign investment across different production stages.

To better understand the development direction of Indonesia's semiconductor industry, this chapter will elaborate further on the semiconductor landscape in Indonesia:

- **Chapter 3.1** explores **Indonesia's semiconductor demand and supply drivers.** Demand comes from consumer electronics, automotive, telecommunications, finance, medical devices, agriculture, and public services. On the supply side, design houses, production facilities, human capital, and R&D play key roles. This chapter also discusses Indonesia's natural resource advantages and geographical positioning in the global semiconductor landscape, given that Indonesia has abundant raw materials for semiconductor manufacturing, including 331 million tonnes of silica sand (3.8% of global exports) [8] and 17.9% of global tin production [9]. Its strategic location near China and Taiwan strengthens its supply chain potential, though material processing remains underdeveloped.

- **Chapter 3.2** supports the **stakeholder analysis** because Indonesia's position in the global semiconductor value chain is shaped by the interaction between domestic and international players. Understanding key global players, major semiconductor-producing countries and trade volumes helps contextualise Indonesia's role and competitiveness. Additionally, comparing Indonesia's human capital and R&D landscape with global benchmarks highlights gaps in talent, research capabilities, and commercialisation potential, which directly impact industry stakeholders, including educational institutions, R&D bodies, and government agencies.

- **Chapter 3.3** reviews **Indonesia's regulatory landscape**, covering fiscal incentives, non-fiscal incentives, as well as other policies and regulations. It also examines comparisons with global semiconductor policies, highlighting key gaps and opportunities for strengthening Indonesia's competitiveness.

- **Chapter 3.4** compares **Indonesia's position in the global semiconductor industry** with leading economies, highlighting gaps in production capacity, R&D, human capital, and policy support. While Indonesia is still in the early stages, strong government commitment and rising domestic demand present opportunities to accelerate development and deepen international engagement.

3.1. Key Demand and Supply Factors Shaping Indonesia's Semiconductor Ecosystem

Indonesia's semiconductor ecosystem is primarily driven by electronic and automotive sectors while other sectors, including finance, public services, medical devices, and agriculture, also contribute to its growth. Electronics sector growth peaked at 13.67% (y.o.y) in 2023 in the past decade, while the automotive sector saw rapid expansion, with BEVs (Battery Electric Vehicle) averaging 502% (y.o.y) annually in 2020-2023 and HEVs (Hybrid Electric Vehicle) surging 2,112% (y.o.y) in 2023. With abundant raw materials, strategic geographical location, availability of infrastructure for semiconductors design and foundry, a growing electronics sector, ATP experience, skilled human capital, and R&D capabilities, the country has the potential to strengthen its position in the global value chain.

Demand Driver of Indonesia's Semiconductor Ecosystem

Semiconductors serve as key components in modern technology hence their demand is expected to continue rising.

Electronics and Automotive as Catalysts for Semiconductor Development

The global and national semiconductor ecosystem has undergone growth in the last few years and likely will continue to expand in tandem with persistent advancements in technology, specifically in the electronics and automotive sectors. As semiconductors serve as vital components of the 'brain' of technology, their continued demand, driven by both security and economic considerations, is expected to grow further, with projections indicating increased semiconductor demand 2030[10],[11]. There are three principal end-market segments for semiconductors, namely computers, consumer electronics, and communications and networking [12]; also acknowledged as the 3Cs. Apart from the 3Cs, the semiconductor ecosystem is also crucial in the automotive industry, as it has a key role powering components such as electric powertrains, advanced driver-assistance systems (ADAS), and in-car infotainment aspects [13]. Both electronics and automotive sectors are expected to also have a notable impact towards Indonesia's semiconductor ecosystem.automotive sectors are expected to also have a notable impact towards Indonesia's semiconductor ecosystem.

Electronic Sector

With more than 270 million total population, the electronic sector holds considerable potential to drive the demand for semiconductors in Indonesia[14]. The COVID-19 pandemic led to a notable increase in global demand for electronics, including Indonesia, as restrictions on physical activities necessitated greater reliance on digital technologies for work, education, commerce, and daily activities[15], [16]. This shift resulted in heightened semiconductor demand, driven further by their growing value share in electronics. Between 1999 and 2021, semiconductors accounted for an average of 24.11% of the total value of electronics, peaking at 33.2% in 2021.

The growing electronics sector continues to drive semiconductor demand, with communications devices (such as smartphones), computers, and consumer electronics accounting for 68% of global semiconductor sales in 2023[17]. These devices relied on semiconductors for both core operations and advanced capabilities [18], as it is a crucial part to construct the devices' processors [11]. In Indonesia the consumer electronics market is expected to grow at an annual rate of 2.18% (CAGR 2025-2029), primarily driven by increasing demand for smart home devices [19].

TABLE 3.1. Indonesia Consumer Electronics Demand Projection

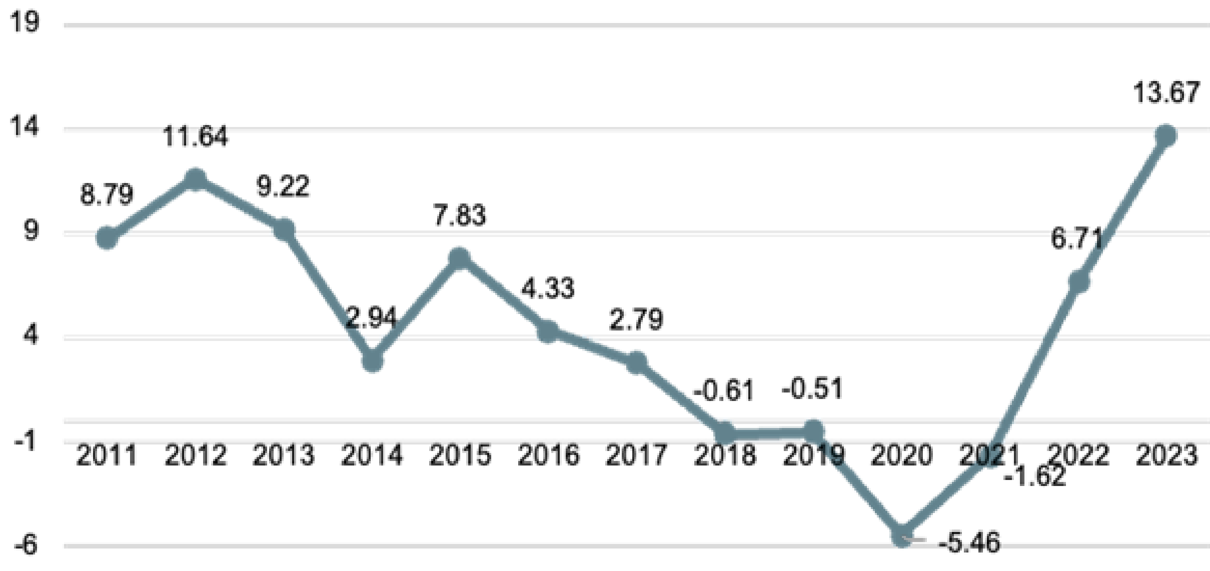
Electronic Goods	2025 (million USD)	2029 (million USD)	CAGR 2025-2029
Telephony	11,790	12,640	1.76%
Computing	3,724	4,249	3.35%
TV, Radio & Multimedia	3,085	3,326	1.90%
Gaming Equipment	226.8	254.5	2.92%
TV Peripheral Devices	138.5	202.2	9.92%
Drones	7.6	9.6	6.01%
Total	**18,980**	**20,690**	**2.18%**

Source: Statista (2025)

Indonesia's electronics sector has demonstrated continuous growth, reinforcing its role as a key driver of semiconductor demand. Classified under the Metal Product, Computer, Electronic, Optic, and Electricity Equipment sector[5], the industry experienced contraction during the pandemic but demonstrated a strong recovery since 2022. The sector recorded a negative growth of 5.46% (y.o.y) in 2020 but rebounded to 13.67% (y.o.y) in 2024 [20]. The sector's annual growth rate in the post-pandemic period, 2022 - 2023, stood at 10.19%, higher than the average annual growth rate of 5.16% in the pre-pandemic period of 2011 - 2019, underscoring the sector's recovery (see Figure 3.3). This figure highlighted the sustained expansion of Indonesia's electronics sector, which not only recovered from the pandemic's impact but continues to strengthen, further driving semiconductor demand.

5 Metal Product, Computer, Electronic, Optic, and Electricity Equipment sector is the most detailed categorisation available for GDP data, as defined by Statistics Indonesia.

FIGURE 3.3. Growth of Metal Products, Computer, Electronic, Optic, and Electricity Equipment (% y.o.y), 2011-2023



Source: CEIC (2024)

Automotive Industry

Aside from electronic sector, various innovations in the automotive industry have driven the demand for the semiconductors ecosystem. Innovations, namely electrification of vehicles and expanding autonomous driving, steered semiconductors demand as non-conventional vehicles require more semiconductor parts than conventional vehicles [21]. Conventional vehicles, automobile powered by oil-derived resources such as gasoline or diesel fuel, encompass about USD 330 value of semiconductors, whereas Hybrid Electric Vehicles (HEV) comprise around USD 1,000 to USD 3,000; or three to ten times higher than conventional vehicles [22]; [23].

Indonesia's total number of vehicles, either conventional, electric, or hybrid, is projected to continue expanding, with an increasing domination of electric and hybrid vehicles. The share of conventional vehicles (ICEV/Internal Combustion Engine Vehicle) to total production of vehicles is experiencing a declining trend, from 99.98% in 2020 to 94.11% in 2023, with projections indicating a further drop to 83.42% by 2030. Meanwhile, the production of electric vehicles has experienced significant growth. BEV (Battery Electric Vehicle) production has surged from 153 units in 2020 to 15,318 units in 2023, growing by 502% (y.o.y) annually on average. In addition, HEV (Hybrid Electric Vehicle) growth has substantially outpaced that of BEV, which production reached 66,863 units in 2023 from 3,009 in 2022, indicating a 2,112% (y.o.y) growth. Rapidly growing electric vehicle production in Indonesia unlocks the possibility for demand of the semiconductor ecosystem.

The government also has a fundamental role in endorsing the EV industry and is attempting to transition the utilisation of conventional vehicles to a more environmentally friendly alternative through the Indonesian Electric Vehicle Industry Development Roadmap. The government established fiscal and nonfiscal policies to reinforce EV production and consumption, including technical requirements for the industry and cost-cutting regulations. The Indonesian Electric Vehicle Industry Development Roadmap advocate Indonesia's EV industry development by regulating local content requirements (LCR) and standardisation of battery electric vehicles [24], [25]. These circumstances also indicate Indonesia's potential to become an EV manufacturing hub, particularly if Indonesia has an established integrated supply chain [25].

Furthermore, other initiatives, such as cost reduction incentives for EV production, along with exemptions from luxury tax (PPNBM), title transfer and ownership fee (BBNKB), and vehicle tax (PKB) aim to boost EV demand by encouraging greater EV adoption.

Other Sectors Driving Semiconductor Development

Besides the electronics and automotive sectors, there are several other sectors with noteworthy contributions to the demand of the semiconductor ecosystem in Indonesia, namely financial transaction cards, medical devices, agricultural devices, and public sector.

1. **Financial transaction cards**
   The manufacturing of Indonesians financial transaction cards, such as ATM cards, debit card, credit card, and chip-based electronic money, encountered considerable growth over the years. Bank Indonesia introduced digitalisation policies and non-cash payment movement in 2014, aiming to create a more efficient and secure payment system. ATM Card, Debit Card, Credit Card, and Chip Based Electronic Money in Indonesia, besides digital payment, is rising in prominence, resulting in an increasing number of cards acquired, with an average annual growth of 11.57% in 2019 – 2023 [26]. These cards are embedded with microchips that facilitate encrypted transactions, ensuring data protection and fraud prevention. Semiconductor technologies enable key security features such as authentication, data storage, and contactless payment capabilities.

2. **Medical devices**
   Indonesia has witnessed a steady increase in its local production of medical devices that require connection to electricity or batteries powered by semiconductors [27]. Indonesia produced 2,126 medical devices locally in 2020, which grew to an estimated 2,808 in 2023 [28]. This remarkable growth of medical devices is expected to affect the semiconductors ecosystem, as a wide range of medical devices comprise semiconductors, from simple blood pressure measuring devices (sphygmomanometer) to much more complicated devices such as imaging devices. In 2019, medical devices demand accounted for roughly 11% (USD 46.01 billion) of the global industrial semiconductor market and 1.3% (USD 5.44 billion) of the total semiconductor market. This sector is expected to expand more rapidly, driven by long-term trends namely population demographics, replacement of older equipment, and addition of medical function to consumer devices [29].

3. **Agricultural devices**
   Indonesia's Ministry of Agriculture underlined the need to transform traditional agriculture to a modern system [30] and is developing various agricultural devices, which drives semiconductors demand. Indonesia is developing various devices such as AI-based Smart Farming 4.0 that include blockchain, drone sprayer, soil and weather sensor, Agriculture War Room (AWR), and Siscrop (information system) [31]. Sensor and detector devices use semiconductors to assist in monitoring the health, welfare, and reproductive cycle of farm animals and soil, to ensure early detection of predicaments and reduce costs. In 2023, there were 46.84% of 28.19 million Indonesian farmers used modern agricultural devices and digital technologies, many of which imported [32]. To reduce the reliance on import, the government sought to boost local production by opening opportunities for investment and collaborating with private companies [33].

4. **Public sector**
Indonesia started to establish e-KTP [6] with semiconductors in 2011 as a part of a comprehensive national-scale multi-application electronic ID system. A Netherlands-based company, NXP Semiconductors, was appointed to produce millions of chips embedded in the electronic ID cards (e-KTP) as a part of the consortium led by Percetakan Negara Republik Indonesia (PNRI). As of 2022, 99.37% of eligible Indonesian have acquired e-KTP, totalling 199 million individuals. The demand for semiconductors in e-KTP will continue to persist with at least 20,000 new cards produced annually to accommodate Indonesians who reach the age of 17 [34].

Supply Driver of Indonesia's Semiconductor Ecosystem

Indonesia has a strong potential to develop its domestic semiconductor supply and expand its role in the global value chain. Key factors that contribute are **the abundance of raw materials, strategic geographical location, institutional presence related to design houses, investment on specialised infrastructure and equipment, existing companies, along with human capital and R&D.**

1. **The abundance of raw materials**
Indonesia possesses abundant natural resources, including quartz sand, bauxite, zinc, coal, and nickel, and is strategically positioned to export semiconductor materials. However, it lacks the advanced processing technology needed to refine these minerals into the ultra-high-purity components essential for semiconductor manufacturing. For example, Indonesia has 332 million tonnes of silica sand reserves (0.9% of global production) which become the main raw material for semiconductors' silicon wafer. The plentiful silica sand reserves have fuelled the government's optimism to promote the development of upstream and intermediate industries by accelerating the downstream process of silica sand into silicon wafers [35]. Silica has the capacity to improve electrical performance, maintain thermal stability, and facilitate surface passivation, coupled with its compatibility and adaptability across diverse applications, underscores its ongoing significance material in the advancement of semiconductor technology [36], [37]. However, the manufacturing process of silica sand to silicon wafers requires various high technologies according to each segmented market. Currently, there are no companies in Indonesia that manufacture silica sand into wafer silicon, implying the importance of upstream industries to extract and process raw materials that could potentially be used in the semiconductor industry. A mapping of Indonesia's current natural resources and position in the global market can be found in Box A.

2. **Strategic geographical location**
Indonesia's strategic geographical location allows it to become a wide-open exporter of semiconductor materials. Indonesia is strategically located between two continents (Asia and Australia) and two oceans (Indian and Pacific), giving it a comparative advantage in trade. This maritime position makes Indonesia an influential player in regional and global commerce. Therefore, as the sixth largest silica sand exporting country, Indonesia could become China's trading partner in silica commodities because of its strategic location on the Malacca Strait and the South China Sea. However, the quality of the products to be exported needs more attention. For example, the semiconductor industry requires silica sand with a high purity level and a very low level of impurity contamination.

6 *Electronic Kartu Tanda Penduduk* (e-KTP) is a computer-based identifier which is given to Indonesian at the age of 17. The e-KTP functions as an individual's identification document, containing personal data, a photograph, and a signature, equipped with a chip that stores demographic data.

3. **The growing presence of design houses**
Existing design houses, science and technology parks, and higher educational institutions have driven development of semiconductor design houses in Indonesia. PT Xirka Silicon Technology, PT TSM Technologies, and Versatile are known for the development of Indonesia's semiconductor ecosystem in design. Furthermore, several science and technology parks (STPs or Technoparks) in Indonesia aim to drive innovation and technological advancement and can be beneficial as the centre of design houses in Indonesia.

Indonesia has also signed a memorandum of understanding (MoU) regarding the establishment of a design house. Polytron, an Indonesian electronics company, has signed an MoU with IMEC (Interuniversity Microelectronics Centre), a Belgian company specialising in nanoelectronics R&D, for research and development. Furthermore, Indonesia Chip Design Collaborative Centre (ICDeC), a nonprofit organisation in IC design, has also signed an MoU with Singapore-based company for mentorship in product chip design programme, focusing on its usage (for example, in electric vehicles).

4. **Establishing specialised infrastructure**
The Special Economic Zone (Kawasan Ekonomi Khusus/KEK), specifically the one on Batam (KEK Nongsa and Tanjung Sauh), is equipped with specialised infrastructure required for semiconductors foundry, with an uncontaminated abundant water supply and robust power system[38]. For logistical purposes, the main road in Batam has been established to facilitate the distribution of manufactured goods. Additionally, Batam operates under a Free Trade Zone (FTZ) status which allows no further costs for goods shipment and is highly suitable for export-oriented industry. Aside from KEK Nongsa and Tanjung Sauh in Batam, the government also projected KEK Singhasari in East Java and KEK Kendal in Central Java in establishing a semiconductor ecosystem. KEK Tanjung Sauh is anticipated to focus on semiconductors itself aiming to connect the domestic and international market, whereas KEK Nongsa focuses on the development of digital technology, data centre, academic institution, and movie and animation production. KEK Singhasari prioritises digital industry for software and KEK Kendal favours EV industry integrated with AI and semiconductors [39].

According to a government representative, the National Research and Innovation Agency (BRIN) is currently constructing the microelectronics laboratory as the centre of excellence for micro and nano electronics. This laboratory will not be exclusively utilised for BRIN, but also for universities and industry. Several buildings intended for research centre have also been onstructed and are yet to be inaugurated in several universities.

5. **Existing companies**
One of the supply drivers supporting the growth of Indonesia's semiconductor ecosystem include the existing ATP companies operating in Indonesia and the existing industries that manufacture other electronic components. PT Infineon Technologies Batam, which is also located in Batam, is one and the only mass-producing semiconductor ecosystem in Indonesia, specialising in ATP (see Box B). It opens the windows of opportunities for the government and academic institutions to collaborate in both research and training aspects of the semiconductor ecosystem. Despite the absence of large-scale manufacturing or foundry companies in semiconductors industry, Indonesia remains active in producing other electronics components classified in KBLI 26120, namely

printed circuit boards (PCBs), printed circuit board assemblies (PCBAs), inductors, resistors, capacitors, and printer motors.

6. **Human capital and research & development**
To bolster the development of the semiconductor ecosystem, Indonesia has been actively working to strengthen its human capital to support the industry. Several initiatives have been carried out in this regard, with collaborations between various entities playing a crucial role. For instance, partnerships between educational institutions (vocational schools and universities) and companies with several objectives: developing and aligning the curriculum to industry needs, introducing the students to the industry ecosystem through apprenticeship programmes, and procurement of related infrastructure and facilities. Furthermore, several universities in Indonesia, such as Institut Teknologi Bandung (ITB), Universitas Indonesia (UI), Universitas Gadjah Mada (UGM), and Institut Teknologi Sepuluh November (ITS), also offer courses related to semiconductor ecosystem, emphasising on semiconductor design to build talent and future workforce. Additionally, public and private entities, both domestic and international, have also actively formed partnerships.

BRIN, as the foundation of Indonesia's R&D, has formulated several schemes to reinforce Indonesia's R&D environment., Indonesia focuses to develop R&D through: (1) the establishment of specialised infrastructure and facilities through STP or Technopark; and (2) collaboration with researchers, companies, international associates, educational institution through various programme, such as Co-Development Programme, Research Mobility Programme, Research and Innovation for Indonesia's Advancement (Riset dan Inovasi untuk Indonesia Maju/RIIM), etc. In addition, private and educational institutions also play a pivotal role in Indonesia's R&D development. For instance, the establishment of ICDeC aims to overcome the major obstacles of R&D in the semiconductor ecosystem by cutting development expenses and making chip design more accessible through the provision of facilities, specialised design services, fabrication support, chip and component manufacturing capabilities, and Multi Project Wafer (MPW) programme.

Box A. Leveraging Natural Resources and Geographical Advantages for Semiconductor Manufacturing

Indonesia possesses abundant natural resources essential for semiconductor production, including silica sand, gallium, germanium, and supporting materials like tin, copper, nickel, and cobalt. Its strategic location enhances its role as a key supplier, particularly for China, given its proximity to major trade routes. However, ensuring high-purity materials is crucial for meeting the stringent requirements of the semiconductor industry.

Key Materials for Semiconductor Production

Indonesia is rich in mineral resources for semiconductors materials, especially silica sand/quartz sand, mineral silicon, gallium, and germanium. These raw materials need to undergo an upstream semiconductor process, which involves the extraction and processing of raw materials to produce components that can potentially be used in the semiconductor industry.

TABLE 3.2. **Key Materials for Semiconductor Production**

Natural Resources	Materials	Usage	Indonesia		
			Reserve	Location	Position among Players
Quartz sand and quartzite rock	Silicon	Fabrication of semiconductor especially in wafer production or substrate material	2,111.23 million metric tonnes in 2021	Sumatra, Bangka, Belitung, Madura-Java, Kalimantan, Sulawesi, and parts of Nusa Tenggara, Maluku, and Papua.	Indonesia ranked sixth in export silicon products. The export volumes increased by 15% from 2021 to 2023. China and Canada were the largest importers of quartz sand in 2023.
Bauxite	Gallium		2.7 billion tonnes	Riau Islands, Bangka Belitung, and West Kalimantan provinces	Indonesia is not included in countries that export Gallium Products. Meanwhile, China has proven to dominate primary gallium exports.
Zinc			Zinc reserves in Indonesia are 2.3 million tonnes	Aceh, North Sumatra, West Sumatra, and Bangka Belitung Islands.	
Coal Fly Ash	Germanium		Indonesia's total coal reserves are 34.8 million tonnes	East Kalimantan, South Sumatra, South Kalimantan, and Central Kalimantan	In terms of germanium product exports, China is the largest followed by Japan second and the US third. Meanwhile, Indonesia is not an exporter of this product.

Source: (MoEMR, 2021), (ANTARA News, 2024), USGS (2020), (Ekonomi Bisnis, 2022), & International Trade Centre (2021 - 2023)

Supporting Materials for Semiconductor Production

With abundant natural resources including copper, nickel, cobalt, and copper, Indonesia also has strong potential to support the semiconductor fabrication, assembly, and packaging (ATP) process, which relies on these key materials for interconnects, insulation, and packaging (See Table 3.3).

TABLE 3.3. **Supporting Materials for Semiconductor Production**

Natural Resources	Materials	Usage	Indonesia		
			Reserve*	Location	Position among Players**
Tin	Tin	ATP: Electronic solder to join electrical components and circuit boards together	Tin metal: 2.17 million tonnes in 2021 Tin ore: 6.8 billion tonnes in 2021	Bangka Belitung Islands, Riau Islands, Riau, West Kalimantan	Indonesia ranked third in 2023, producing 52,000 metric tonnes, contributed 17.8% of total global tin production. While China remained the world's largest producer & reserves.

Natural Resources	Materials	Usage	Indonesia		
			Reserve*	Location	Position among Players**
Copper	Copper	Fabrication and ATP: Interconnects connecting transistors and transmitting signals within complex circuits.	Copper metal: 19 million tonnes in 2021 Copper ore: 3 billion tonnes in 2021	Nusa Tenggara, Papua, Java, and Kalimantan	Indonesia is in seventh place with a production output of 840 thousand metric tonnes or approximately 3.8% of the world's total copper mine production in 2023. Chile is the country with the largest copper production in the world (5 million metric tonnes).
Nickel	Nickel	Fabrication and ATP: Nickel-based alloys are widely used in encapsulation shells, cables, and connectors, which provide strong protection and ensure stable signal transmission.	Nickel metal: 57.1 million tonnes in 2021 Nickel ore: 5.2 billion tonnes in 2021	Central Sulawesi, South Sulawesi, Southeast Sulawesi, North Maluku	By 2023, mining in Indonesia, which is the leading nickel producer in the world, is expected to produce 1.8 million metric tonnes of nickel. Furthermore, the Philippines has the second largest production volume with 400,000 metric tonnes.
Cobalt	Cobalt	Fabrication: Conductor in the manufacture of transistor contacts and interconnects. Cobalt enables lower vertical resistance in the interconnect path compared to copper	Cobalt metal: 0.48 million tonnes in 2021 Cobalt ore: 0.68 billion tonnes in 2021	Sulawesi, Maluku, several areas in Papua, and in Aceh	In 2023, Indonesia ranked second with 7% cobalt mine production (17,000 metric tonnes). Meanwhile, Democratic Republic of Congo (Kinshasa) is the world's leading source of mined cobalt accounting for 74%.

Source: * MoEMR (2021) and ** Statista (2024)

3.2. Key Stakeholders in Indonesia's Semiconductor Ecosystem

Strengthening Indonesia's semiconductor ecosystem requires collaboration between domestic and global stakeholders. Domestically, the government agencies, the semiconductor players, educational institutions, and research bodies are coordinated by the Semiconductor Task Force to enhance global integration. Global stakeholders, consisting of the global industry players, government, and universities, contribute through IP licensing, knowledge sharing, and technology transfer. Together, they establish a robust framework covering material extraction, design, fabrication, assembly, testing, and packaging (ATP), advancing Indonesia's position in the global semiconductor landscape.

Key Domestic Players in Indonesia's Semiconductor Industry

Domestic players include the government, semiconductor ecosystem and players, workforce & educational institutions, and research institutions, coordinated by the Semiconductor Task Force to drive integration into global supply chains.

Government and Semiconductor Ecosystem Preparation Task Force

The Government of Indonesia plays a substantial role in developing the country's semiconductor ecosystem. A detailed overview of government stakeholders and their respective roles is presented in Table 3.4.

TABLE 3.4. Government Role in the Semiconductor Ecosystem of Indonesia

No	Institution	Directorate	Role in Semiconductor	Description
1	Ministry of Development Planning	Directorate of Macro Planning and Statistical Analysis	Mineral Processing; Design; and Assembly, Testing, and Packaging	Integrated the semiconductor industry development plan into the 2025–2029 National Medium-Term Development Plan *(Rencana Pembangunan Jangka Menengah dan Panjang/RPJMN).*
2	Coordinating Ministry of Economic Affairs	Semiconductor Ecosystem Preparation Task	Mineral Processing; Design; and Assembly, Testing, and Packaging	Aim to create a comprehensive and sustainable environment to attract and support investments in the semiconductor and establish a unified direction for semiconductor development. **Established Coordination:** Unify government agencies, professionals, NGOs, and embassies to drive ecosystem growth. **Policy Integration:** Secured semiconductor inclusion in the 2025-2029 RPJMN, ensuring long-term government commitment. **Global Engagement:** Participate in the ITSI Fund as well as collaborate with OECD and U.S initiatives to advance design house investments in Indonesia. **FDI Enhancement** for the semiconductor ecosystem in Indonesia.
3	Ministry of Energy and Mineral Resources	Directorate General of Mineral and Coal	Mineral Processing	Responsible for implementing the export restriction policy for minerals commodities, including silica, through the Minister of ESDM Decree No. 296.K/MB.01/MEM.B/2023.
4	Ministry of Industry	Directorate General of Chemical, Textile, and Miscellaneous Industries	Mineral Processing	Plan a silica downstream policy to support the development of the semiconductor industry in Indonesia. As an initial step, the Ministry of Industry has formulated the Silica/Quartz Commodity Downstream Policy Action Plan,

No	Institution	Directorate	Role in Semiconductor	Description
				starting with the drafting of the Silica Downstream Roadmap into Silicon Wafers for 2025–2035.
5	Ministry of Industry	Directorate of Electronics and Telecommunications Industry		
6	Ministry of Environment and Forestry	Directorate General of Natural Resources and Ecosystem Conservation	Mineral Processing	Oversees the environment of mining activities, including silica and other semiconductor mining materials, through Law No. 32 Year 2009 on Environmental Protection and Management. The regulation requires mining activities to follow the environmental minimum requirement through Environmental Impact Assessment *(Analisis Mengenai Dampak Lingkungan*/AMDAL*)* and Environmental Management and Monitoring Plan *(Upaya Pengelolaan Lingkungan dan Upaya Pemantauan Lingkungan*/UKL-UPL).
7	Ministry of Industry	Directorate General of Chemical, Textile, and Miscellaneous Industries	Assembly, Testing, and Packaging	Support the domestic industry, such as local content requirements (Tingkat Komponen Dalam Negeri/TKDN), import restrictions, and tax incentives, serve as foundational measures to foster the growth of the local semiconductor products. The Ministry of Industry of Indonesia issued Regulation No. 65/M-IND/PER/7/2016, detailing the provisions and procedures for calculating TKDN for electronic devices, such as mobile phones, handheld computers, and tablets. Furthermore, the Ministry of Industry is also in charge of managing the importation of electronic products including semiconductor with Ministerial Regulation No. Year of 2024.
8	Ministry of Industry	Directorate of Electronics and Telecommunications Industry		
9	Ministry of Finance	Directorate General of Taxation	Design; and Assembly, Testing, and Packaging	The Tax Holiday falls under the joint authority of the Ministry of Industry and Ministry of Finance and is regulated through Minister of Finance Regulation (PMK) No. 69 of 2024 which extended the corporate income tax exemption for industries until the end of 2025. The government has also tried to promote research and development (R&D) in the semiconductor industry by providing incentives in the form of tax-deductible expenses for private companies that allocate their Corporate Social Responsibility (CSR) efforts to support industry-related studies, including those in the semiconductor sector, as outlined in Government Regulation No. 93 of 2010.

No	Institution	Directorate	Role in Semiconductor	Description
10	Ministry of Finance	Directorate General of Bea Cukai	Design; and Assembly, Testing, and Packaging	Support the semiconductor ecosystem as a trade facilitator. Facilities such as the Ease of Import for Export Purposes *(Kemudahan Impor Tujuan Ekspor*/KITE) and Bonded Storage Facilities *(Tempat Penimbunan Berikat*/TPB) allow for the suspension of import duties on raw material imports, thereby enhancing efficiency and competitiveness within the relevant industries.
11	Ministry of Finance	Secretariat General, under Education Fund Management Institution *(Lembaga Pengelola Dana Pendidikan*/LPDP)	Design	Initiate scholarship programmes to enhance expertise specialised in chip design and microelectronics, by offering Master and Doctoral education opportunities in Semiconductor and Advanced Device Engineering in the University of Science and Technology, South Korea in 2024.
12	Ministry of Manpower	Directorate General of Labour Inspection Development and Occupational Safety and Health	Design; and Assembly, Testing, and Packaging	Enforces Occupational Safety and Health (OSH) standards across various industries, including semiconductors. Following reports of forced labour in Indonesia's nickel industry, the government has committed to improving supervision of regulations and international standards to prevent such violations. This includes ensuring compliance with OSH standards to protect workers from hazardous conditions.
13	Ministry of Manpower	Directorate General of Vocational Training Development and Productivity	Assembly, Testing, and Packaging	Enhance workforce competencies in semiconductor through issuing the Presidential Regulation No. 68 of 2022 on Vocational Education and Training Revitalisation, aiming to align vocational graduates with industry needs through active collaboration.
14	Ministry of Primary and Secondary Education	Directorate General of Vocational Education	Assembly, Testing, and Packaging	
15	Ministry of Higher Education, Science, and Technology	Directorate General of Higher Education	Design	Responsible for supporting the semiconductor environment and developing talent in semiconductor through integrated curriculum education, industrial training, and research and development activities to enhance innovation.

Source: Compilation from several sources, summarised by LPEM FEB UI (2025)

Industry Players

The presence of semiconductor companies across various production stages in Indonesia remains limited, each of these can be explained as follows:

1. **Industry Players in Material Extraction**
Currently, no companies operate in material processing that meets the required silicon purification standards (for further details, see Annex E). However, in material extraction, Indonesia hosts 328 companies involved in silica reserves [40]. Among these, 98 hold Mining Business Permits *(Izin Usaha Pertambangan*/IUP), and 82 hold a specific exploration IUP.

2. **Industry Players in Design**
In the design stage, Versatile Systems and Technologies, PT Xirka Silicon Technology, and PT TSM Technologies stand out as the Integrated Chip (IC) design companies in Indonesia.

   - **Versatile Systems and Technologies**, based in Depok, West Java, specialises in producing: (1) Smartcard and RFID solutions; (2) Cloud-based digital signage and Videotron solutions; (3) Alarm, security, and tracking systems; and (4) Motorcycle parts and accessories [41].
   - **PT Xirka Silicon Technology**, established in 2007, was the chip design house in Indonesia that focused on the development of WiMAX baseband chipsets and delivered a System-on-Chip (SoC) for Broadband Wireless Access (BWA)[41]. PT Xirka Silicon Technology is involved in medical products, the Internet of Things (IoT), and Artificial Intelligence (AI).
   - **PT TSM Technologies** is an Original Design Manufacturer (ODM) which designs and manufactures products, contrasting with Original Equipment Manufacturer (OEM) which only manufactures already designed products [42].

Unlike PT Xirka Silicon Technology, which has more focus on semiconductor design, Versatile Systems and Technologies and PT TSM Technologies have an emphasis on its cutting-edge R&D and manufacturing in health technologies, AIoT, cloud computing, and 4G/5G cellular.

3. **Industry Players in Assembly, Test, and Packaging**

A global semiconductor manufacturer, Infineon, operates a facility in Batam, Indonesia, specialising in Assembly, Test, and Packaging (ATP) processes. PT Infineon Technologies Batam plays a key role in the semiconductor supply chain by handling back-end processes while also contributing to local employment (see Box B).

Box B. PT Infineon Technologies Batam: Indonesia's Sole Assembly, Test, and Packaging (ATP) Facility

PT Infineon Technologies Batam operates under an export-oriented model, specialising in automotive semiconductors. The facility employs over 2,000 workers and specialises in ATP, with all semiconductor components sourced from abroad. As a subsidiary of the German multinational Infineon Technologies, the facility focuses exclusively on ATP, while chip design and fabrication are conducted in Germany, Austria, Malaysia, and Singapore. Although production capacity has expanded over time, the company does not supply semiconductors to the domestic market. Instead, all processed chips are exported, with some returning to Indonesia as components in electric vehicle modules.

Despite these constraints, **PT Infineon Technologies Batam has continued to expand its ATP capacity to meet rising global demand.** In 2020, the facility had a weekly production capacity of 22 million semiconductor units. To strengthen its position as a key ATP hub, the company has set ambitious expansion targets, aiming to increase capacity to 65 million units per week by 2025 and 150 million units per week by 2030.

Workforce and Educational Institution

The semiconductor ecosystem depends on a skilled workforce, with educational institutions playing a key role in talent development. Workforce demand varies across different stages of the semiconductor value chain, with the design stage requiring highly educated professionals, while the ATP stage demands a larger workforce with technical skills.

Higher education and vocational institutions contribute to workforce development through specialised programmes and industry collaborations. Batam State Polytechnic (*Politeknik Negeri Batam*/Polibatam) is one of the few Indonesian institutions offering a dedicated semiconductor programme through its Department of Manufacture of Electronics, focusing on chip components for mobile phones, computers, and electric vehicles [43]. In addition to its curriculum, Polibatam collaborates with industry stakeholders to enhance workforce skills, including a training programme for PT Infineon Technologies Batam in partnership with the Ministry of Industry in October 2022 [44].

In addition to specialised programmes and industry collaborations, Indonesian universities have increasingly engaged with global universities to strengthen semiconductor talent development. These collaborations facilitate knowledge exchange and enhance expertise, particularly in semiconductor design. For instance, in August 2024, ITS organised the International Conference on Sustainable Semiconductor Manufacturing in partnership with the National Taiwan University of Science and Technology, bringing together professionals from Indonesia, Taiwan, and the United States [45]. Similarly, in January 2025, ITB hosted a symposium with Tsinghua University to discuss advancements in semiconductor manufacturing and biomanufacturing in medical field [46].

Vocational High Schools (*Sekolah Menengah Kejurua*n/SMK) also contribute to semiconductor workforce development, although their role remains limited. While no SMK currently offers a specialised semiconductor programme, related fields, such as mechanical engineering, electronics, and industrial automation provide some industry exposure. Several SMKs collaborate with industry partners to ensure alignment between industrial demands and the competencies of graduates. For instance, SMKN 1 Semarang has established long-term partnerships with PT Uni Traktor Indonesia (UTI), PT BUMA, and Panasonic to facilitate graduate employment to be fitted in the industry as early-stage workers. Additionally, SMKN 1 Semarang has also received various equipment and machinery grants from domestic and international companies and institutions, including Snetzer and Politeknik META Industry, with funding from the Government of France.

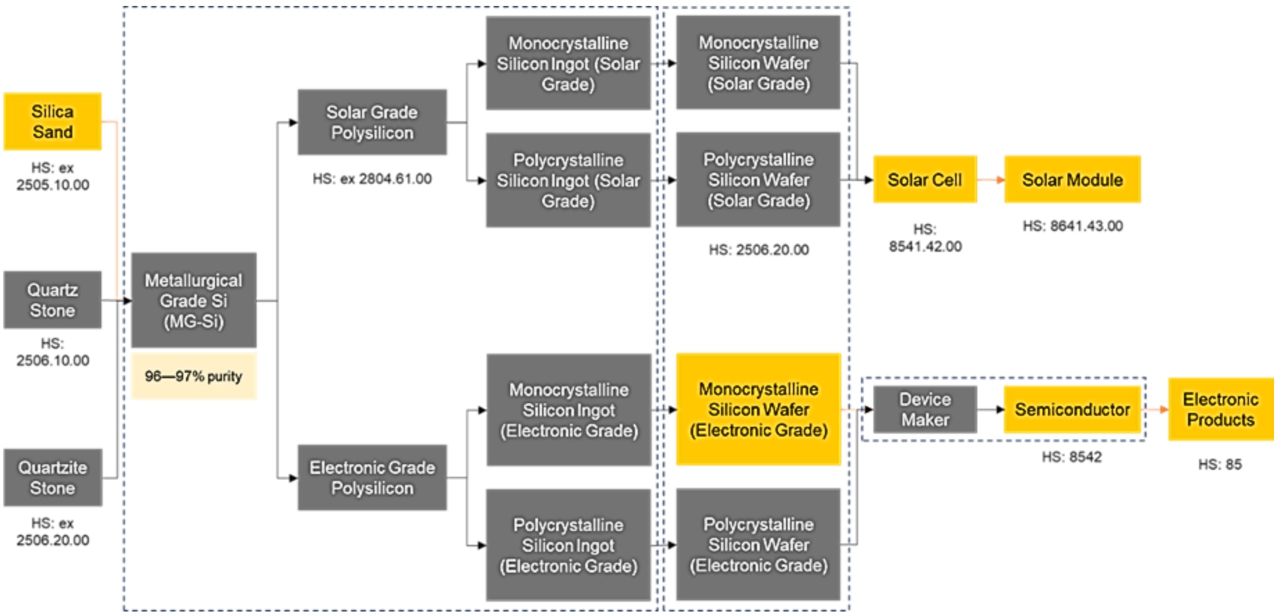
Research and Development Institution

Responding to the global semiconductor industry's rapid technological advancement, the Indonesian government explicitly states semiconductor industry development as a top national priority in the National Medium-Term Development Plan (RPJMN) 2025–2029. The Making Indonesia 4.0 initiative was launched to transform Indonesia into a global manufacturing hub with a strong semiconductor ecosystem. A key strategic measure includes increasing the national R&D investment to 2% of GDP, demonstrating a commitment to technological mastery and development initiatives.

To accelerate semiconductor R&D, the Indonesian government currently hosts 21 science and technology parks (STPs), though this remains below the RPJMN 2019–2024 target of 100 STPs. These STPs serve as collaborative ecosystems, bridging academia, industry, and government to foster innovation and technological advancement. The gap between the number of STPs and its target persists due to a lack of scientists. However, STP development continues through strategic collaborations between universities and the private sector, which provide high-skilled human resources to support STP development.

As a pillar of Indonesia's R&D, the National Research and Innovation Agency (Badan Riset dan Inovasi Nasional/BRIN), particularly through the Electronics and Informatics Research Organisation (OREI), has strategically established STP Samaun Samadikun. This STP reflects Professor Samaun Samadikun's dedication, who pioneered the establishment of a microelectronics laboratory. Focusing on micro-nano electronic research, the STP Samaun Samadikun is equipped with advanced device fabrication and measurement instruments, including the Laser Direct Write System (LDWS), Plasma Enhanced Chemical Vapor Deposition (PECVD) System, Magnetron Sputtering System, Atomic Layer Deposition (ALD), Wafer Probe Station, and Semiconductor Parameter Analyser. Additionally, OREI actively researches optoelectronic devices, including light-emitting diodes (LEDs) and optical sensors, as well as the application of thermoelectric devices in energy harvesting.

FIGURE 3.4. **BRIN Research Support in Semiconductor Materials**



Source: Adapted from slides of Government Officials Interviews

BRIN also supports research on semiconductor materials, involving basic material processing to semiconductor applications. As can be seen in Figure 3.4, basic material research includes transforming quartzite stone into metallurgical-grade silicon, purifying polysilicon, solar, and electronic grade, as well as manufacturing wafers for semiconductor devices, involving crystallisation and precision cutting process. The final stage focuses on developing diverse semiconductor materials with wide-ranging applications such as (1) sensing technologies (e.g., detector/sensor, chemical elements, light communication, biosensors, and particle detection); (2) electronic components (e.g., RFID, LED, and high-power GaN-based devices); (3) specialised ICs.

Moreover, BRIN's semiconductor research roadmap prioritises biosensors, solar cells, energy harvesting, RF/Microwave devices, and memristors. The biosensor research focuses on detecting cancer, malaria, and tropical diseases, which are significant in healthcare. In the field of solar cells, the study aims to optimise tandem photovoltaic devices and scale high-performance solar cells while ensuring reliability and integration with other electronic technologies. Alongside energy harvesting, these initiatives are expected to contribute significantly to the country's renewable energy and sustainability goals. Meanwhile, RF/microwave devices and memristors are being developed to support communication technologies. In addition to the above-mentioned initiatives, BRIN also engages with global partners in semiconductor research, such as a partnership with the University of Southampton, United Kingdom, to develop AI-integrated hard disk technology (see Box E).

Beyond formal R&D institutions, industry players contribute to research and human capital development through their Corporate Social Responsibility (CSR) initiatives. One of the examples is Polytron, a local electronics company, has signed a Memorandum of Understanding (MoU) with IMEC (Interuniversity Microelectronics Centre), a globally renowned research and development organisation specialising in nanoelectronics and digital technologies headquartered in Belgium. This collaboration represents a critical milestone in Indonesia's semiconductor research ecosystem, aimed at deepening front-end core knowledge such as foundational knowledge, advanced design skills for complex ICs, and system-on-chip (SoC) development methodologies.

Together with 13 universities[7] in Indonesia, Polytron has also initiated the Indonesia Chip Design Collaborative Centre (ICDeC), a non-profit organisation dedicated to the development of human resources and technology in the field of Integrated Circuits (IC) in Indonesia[47]. Launched in 2023, ICDeC aims to address the financial barriers in semiconductor R&D by reducing development costs and lowering barriers to chip design. Through this initiative, Indonesian universities have the opportunity to strengthen their role in the semiconductor industry, not only by fostering innovation but also by forming partnerships with local and global companies.

Several universities have already made progress in this field, with five leading institutions, ITB, UI, UGM, ITS, and UNDIP, developing semiconductor chips tailored to specific industry clusters. The following outlines of specialised semiconductor research[8] pursued by these universities.

7 Universitas Indonesia (UI), Institut Teknologi Sumatera (ITERA), Universitas Mataram (UNRAM), Universitas Pertamina, Universitas Diponegoro (UNDIP), Universitas Gadjah Mada (UGM), Institut Teknologi Bandung (ITB), Universitas Brawijaya (UB), Universitas Andalas (UNAND), Universitas Prasetiya Mulya, Politeknik Negeri Batam (Polibatam), Universitas Telkom, and Institut Teknologi Sepuluh Nopember (ITS).

8 These research initiatives position Indonesian universities as potential partners for both local and global companies, including Telkom Indonesia, ASTRA Automotive, Polytron, TSMC, and Excelitas.

- ITB has been developing chip designs for the consumer product cluster, with potential applications in smart home devices, electronic cards, and payment systems.

- UI and ITS are focusing on the Radio Frequency (RF) cluster and audio cluster, respectively. The RF cluster developed by UI can be applied in wireless devices, remote sensors, and alternative communication architectures. In contrast, ITS's audio cluster can be utilised in active speakers, sound systems, and medical acoustic devices.

Global Players Shaping Indonesia's Semiconductor Ecosystem

Beyond their presence, **global players play a role in supporting industry development by facilitating Intellectual Property (IP) licensing, knowledge sharing, and technology transfer,** strengthening Indonesia's integration into the ecosystem.

1. **IP Licence Holders**
   The global players, especially the IP licence holders, have a role in the semiconductor ecosystem. IP licensing is granted to companies or countries that fund the research and development of the chip. If Indonesia utilises chip design IP from other countries, Indonesia will be required to pay licensing fees for the use of such designs. US became one among countries with IP chip holders in semiconductor. In 1984, the US introduced the Semiconductor Chip Protection Act (SCPA) to enable intellectual property protection for the layout designs of semiconductor integrated circuits. Example?

2. **The Global Value Chain Companies**
   The Global Value Chain companies also play a role as many global semiconductor companies focus exclusively on one of many semiconductor chains. For example, NVIDIA and Qualcomm specialise in chip design, while X-FAB and TSMC are primarily involved in wafer foundry operations (see Box C). In Global Value Chain, Indonesia currently has only one company capable of performing ATP, the Infineon Batam. Consequently, Infineon Indonesia relies on imports from other countries to obtain semiconductor components for the ATP operations

3. **Partnerships with Governments & Universities**
   Global players are also responsible for collaboration and partnership activity. Collaborations and partnerships are held both at governmental level between Indonesia and other countries and within industry and academic sectors. For example: MOU between ICDeC and Interuniversity Microelectronics Centre (IMEC) and MOU between Indonesian government and Arizona State University (ASU) and Purdue University. Furthermore, Indonesia attended Electronica 2024, European largest semiconductor exhibition that is expected to give access to further collaboration in the semiconductor human development, training, research, and technology transfer.

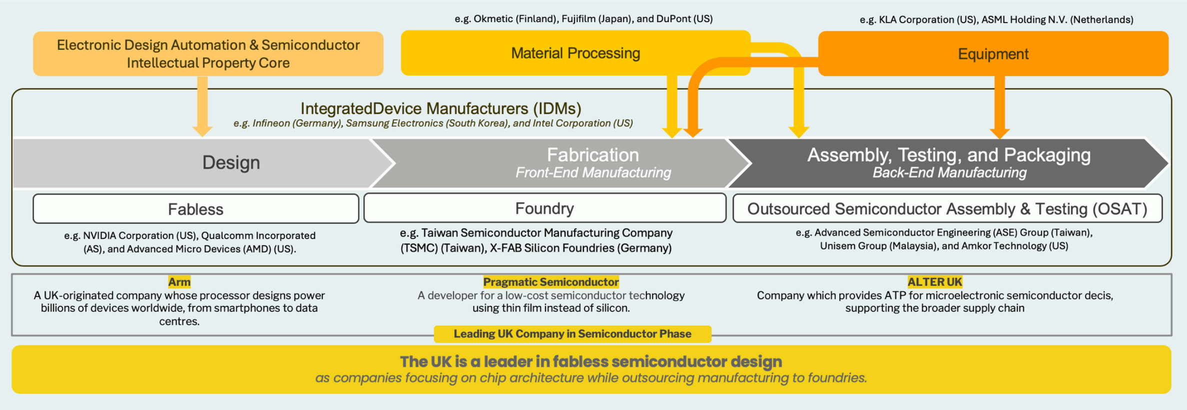
4. **Global Semiconductor Association**
   The role of global players also aligns in the global semiconductor association, such as World Semiconductor Council (WSC) and Global Semiconductor Alliance (GSA). WSC is an association representing the largest market share holders in the global semiconductor industry, while GSA is assisting semiconductor companies worldwide through networking, advocacy, and knowledge-sharing initiatives. At the regional level, there is SEMI Southeast Asia, uniting the electronics manufacturing and design supply chain in the Southeast Asia region. However, Indonesia has a limited role in global and regional semiconductor associations.

Box C. Global Player in Semiconductor

The global semiconductor industry is dominated by a few key economies, with the **U.S. and Europe leading in design,** while **China, Taiwan, and South Korea dominate manufacturing. China leads in GDP contribution and exports,** while **Indonesia lags but is projected to have the highest growth rate**, especially in **fabless semiconductor design and assembly, packaging, and testing (APT)** of microelectronic semiconductor devices, supporting the broader supply chain.

Global Players in the Semiconductor Value Chain

FIGURE 3.5. **Semiconductor Production Process and Global Value Chain**



Source: Adapted from an interview with Industry Expert and modified according to Kleinhans & Baisakova (2020) and interviews with multiple stakeholders in the semiconductor industry (2025)

The global semiconductor industry is shaped by key players specialising in different stages of the production process (See Figure 3.5). Some companies operate across all three stages, design, fabrication, and ATP (assembly, testing, and packaging), and are known as Integrated Device Manufacturers (IDMs). Leading IDMs include Infineon (Germany), Samsung Electronics (South Korea), and Intel Corporation (US).

For greater economic efficiency, many companies specialise in a single production step. Fabless companies focus solely on chip design and outsource manufacturing to foundries. **Major fabless firms include NVIDIA Corporation (US), Qualcomm Incorporated (US), and Advanced Micro Devices (AMD) (US), all of which depend on foundries for fabrication.**

Foundries manufacture chips based on designs provided by fabless companies. **Key global foundries include Taiwan Semiconductor Manufacturing Company (TSMC) (Taiwan), X-FAB Silicon Foundries (Germany), and United Microelectronics Corporation (UMC) (Taiwan).** Once fabricated, semiconductors undergo ATP (assembly, testing, and packaging) before reaching the market. This process can be handled either by foundries or **Outsourced Semiconductor Assembly and Test (OSAT) providers, such as Advanced Semiconductor Engineering (ASE) Group (Taiwan), Unisem Group (Malaysia), and Amkor Technology (US).**

Beyond direct semiconductor production, supporting industries play a role in enabling the fabrication and ATP processes. Materials processing, or upstream semiconductor processes, provide essential raw materials, including silica, germanium, and gallium for wafer fabrication and tin for assembly. **Leading global material processing companies include Okmetic (Finland), Fujifilm (Japan), and DuPont (US).** Additionally, semiconductor manufacturing depends on highly specialised equipment tailored to specific production needs.

Major semiconductor equipment manufacturers include KLA Corporation (US), ASML Holding N.V. (Netherlands), and Applied Materials, Inc. (US).

The UK is a leader in fabless semiconductor design, with companies focusing on chip architecture while outsourcing manufacturing to foundries. A prime example is **Arm**, a UK-originated company whose processor designs power billions of devices worldwide, from smartphones to data centres. Although the UK lacks large Integrated Device Manufacturers (IDMs) like Intel or Samsung, it has smaller companies with IDM capabilities, particularly in power semiconductors and specialised applications. **Pragmatic Semiconductor** is a key example, developing low-cost semiconductor technology using thin film instead of silicon. The UK also has a presence in **Outsourced Semiconductor Assembly and Test (OSAT) services. ALTER UK** is an example of a company that provides assembly, packaging, and testing for microelectronic semiconductor devices, supporting the broader supply chain.

3.3. Policies and Regulations Governing Indonesia's Semiconductor Ecosystem

The Indonesian government provides various incentives and policy support for industrial development, including fiscal incentives such as tax allowances, tax holidays, R&D benefits, and royalty incentives. Additionally, policy and regulatory measures focus on raw material security, local content requirements, workforce development, and intellectual property protection to enhance overall industrial competitiveness. However, these incentives apply to the broader industry rather than being specifically tailored to the semiconductor sector.

Fiscal and Nonfiscal Incentives

The Indonesian government has established a series of fiscal and non-fiscal incentives to encourage investment in various industries, including the semiconductor sector, which is categorised as a priority sector in the national industrial strategy [49]. These incentives aim to improve Indonesia's competitiveness in the global supply chain, attract foreign investment, and accelerate the development of domestic semiconductor infrastructure and ecosystems. This section outlines the various fiscal incentives provided by the government, including tax deduction facilities, tax holidays, and support for research and development (R&D) aimed at reducing the fiscal burden for investors while encouraging technological innovation. In addition, nonfiscal incentives include various supporting facilities such as ease of business licensing, land provision, infrastructure development, and human resource capacity building. This combination of fiscal and non-fiscal incentives forms a strategic policy that is expected to accelerate the growth of the semiconductor ecosystem and make Indonesia an attractive investment destination for high-tech industries.

Fiscal Incentives

While not specifically designed for the semiconductor industry, Indonesia offers three key fiscal incentives that semiconductor companies may utilise:

1. **Tax allowances and tax incentives**
   The Government of Indonesia provides tax allowances and corporate tax incentives to alleviate financial burdens on investors and enhance industrial competitiveness. These incentives are available to corporate taxpayers across various industries, including the semiconductor sector, who meet criteria such as high investment value, high local content, or the creation of significant employment opportunities. A structured tax relief system encourages companies to establish and expand semiconductor-related operations in Indonesia, fostering economic growth and job creation. Under Government Regulation No. 78/2019 and Minister of Industry Regulation No. 47/2019, semiconductor companies that meet investment and local content requirements can receive a 30% net income reduction over six years, in addition to accelerated depreciation and amortisation benefits [50], [51]. This policy not only reduces operational costs for investors but also strengthens Indonesia's semiconductor ecosystem by attracting multinational corporations to set up facilities in the country.

2. **Tax exemptions**
   To enhance Indonesia's attractiveness as a semiconductor manufacturing hub, the government offers corporate income tax exemptions for large-scale investments. The tax holiday policy incentivises long-term investments by reducing tax obligations, allowing companies to reinvest capital into infrastructure and workforce development. Under Law No. 25/2007 on Investment and Ministry of Finance Regulation No. 130/2020 on Corporate Income Tax Reduction Facility, companies can obtain up to a 100% corporate income tax exemption for five to twenty years, depending on the investment size. Investments exceeding IDR 1 trillion qualify for a maximum 20-year tax holiday, while investments between IDR 500 billion and IDR 1 trillion receive a five-year exemption. By adopting this policy, Indonesia enhances its potential to become a key player in the global semiconductor supply chain while reducing reliance on imported components [52], [53].

3. **R&D incentives and Intellectual Property (IP) protection measures**
   Indonesia offers tax incentives and royalty benefits to encourage semiconductor R&D, fostering collaboration between academia and industry to strengthen domestic innovation and reduce reliance on foreign technology. Ministry of Finance Regulation No. 153/2020 provides up to a 300% gross income deduction for semiconductor-related R&D activities, including chip design and efficiency improvements. Additionally, Ministry of Finance Regulation No. 136/PMK.02/2021 grants royalty incentives to researchers and universities for licensing semiconductor-related patents and intellectual property rights. These measures are intended to foster collaboration between academic institutions and industry stakeholders, strengthening Indonesia's semiconductor research capabilities and reducing reliance on foreign technology [54], [55].

Non - Fiscal Incentives

Other than fiscal incentives, **the Government of Indonesia also provides various nonfiscal facilities that can support the investment climate.**

1. **Industrial facilities and infrastructure:** The Government of Indonesia provides land in industrial estates equipped with essential infrastructure, including transportation access, electricity, water supply, and telecommunications. Government Regulation No. 20 of 2024 on Industrial Zoning requires both central and regional governments to ensure that these facilities are in place to support efficient industrial [56].

2. **Workforce development:** Recognising the need for skilled labour in the semiconductor industry, the Government of Indonesia promotes training programmes and certification schemes. These initiatives aim to equip workers with technical expertise, improving industry competitiveness and operational efficiency.

3. **Simplified business licensing:** The Online Single Submission (OSS) system, established under Law No. 11 of 2020 on Job Creation, streamlines the licensing process, making it easier for companies to set up and expand their operations. This system reduces bureaucratic obstacles and improves the ease of doing business in Indonesia [57].

4. **Product certification and compliance support:** To help companies meet domestic and international standards, the government facilitates product certification and ensures compliance with technical regulations. This support strengthens the credibility of locally manufactured semiconductor products in the global market.

5. **Spatial planning:** Spatial planning adjustments and regulatory support are provided to accelerate industrial development. By easing logistical and administrative constraints, these measures facilitate the growth of the semiconductor industry [56].

Other Policies and Regulations

One of the crucial regulations for the development of Indonesia's semiconductor ecosystem is regulations related to silica sand and raw materials downstreaming. Indonesia plans to ban the export of silica sand by 2027 to ensure the availability of raw materials for the domestic semiconductor ecosystem [35]. As part of the downstreaming strategy, the government is developing the Silica Downstreaming Roadmap 2025-2035, which is expected to develop a production chain from silica sand to silicon wafers as the main material for the semiconductor ecosystem [35]. This policy aims to reduce import dependence and strengthen the competitiveness of the national industry. However, the implementation of this policy may face significant challenges, particularly in attracting investment for processing infrastructure and advancing the necessary manufacturing technology. Although Indonesia has abundant silica sand reserves, the domestic industry has not yet developed the capacity to process silica into electronic-grade silicon (EGS) required in semiconductor production (for further elaboration, refer to Annex E).

Local Content Requirements

Building on the efforts to strengthen the national semiconductor ecosystem, the Local Content Requirements (LCRs) policy is a strategic instrument in encouraging the strengthening of the national semiconductor ecosystem. LCRs require products manufactured and marketed in Indonesia, including electronic devices, to contain a certain percentage of locally sourced components. This policy has direct implications for the semiconductor ecosystem, as semiconductors are fundamental to a wide range of electronic products. Under Government Regulation No. 29/2018, LCRs are enforced to enhance the role of domestic industries in the global value chain. For certain electronic products, such as smartphones and telecommunication devices, the government has set a minimum local content requirements (LCRs) threshold, which indirectly drives demand for domestically produced semiconductors [58]. However, the success of this policy hinges on the readiness of the domestic semiconductor ecosystem.

Currently, Indonesia's semiconductor ecosystem remains heavily reliant on imports for raw materials, production machinery, and fabrication technologies. To fully leverage the LCRs policy, it is essential to provide investment incentives that encourage the development of local semiconductor production facilities and bolster research and innovation capabilities. Additionally, the LCRs policy also has the potential to attract foreign investors, especially global semiconductor companies that want to take advantage of local incentives and comply with local content requirements. With a well-crafted strategy, LCRs can serve as a catalyst for accelerating the growth of Indonesia's semiconductor ecosystem while fostering greater independence in the national electronics sector.

Labour Policy and Regulation

Labour regulations in the semiconductor ecosystem in Indonesia are outlined through the Indonesian National Work Competency Standard (SKKNI) No. 130/2024 to ensure workforce readiness. This regulation sets labour competency standards in various aspects of the semiconductor ecosystem, including IC design, fabrication, quality testing, equipment engineering, and chip assembly. These standards serve as a reference in labour certification, vocational training, and skills upgrading to ensure workforce readiness in high-tech [59].

In addition, the recruitment of foreign workers in the semiconductor ecosystem is regulated in Government Regulation No. 34/2021 and Minister of Manpower Regulation (Permenaker) No. 8/2021, which regulates the licensing mechanism, the obligation to transfer technology to local workers, and the requirements for the Foreign Worker Usage Plan. These regulations aim to ensure that the presence of foreign experts benefits the domestic workforce through knowledge sharing and skill development [60], [61]. However, a significant challenge lies in the lack of training institutions capable of producing workers who meet global semiconductor ecosystem standards. To address this, collaboration between the government, industry stakeholders, and academic institutions is essential to develop a robust workforce ecosystem. In conclusion, by strengthening labour policies and investing in workforce development, Indonesia can create a competitive and skilled labour force to support its semiconductor ecosystem.

Intellectual Property Rights

Intellectual Property Rights (IPR) play an important role in the semiconductor ecosystem, especially in protecting patents, copyrights, and technology licences related to integrated circuit designs, manufacturing processes, and software supporting chip testing and production. In Indonesia, IPR protection is regulated in several regulations, including Law Number 13 of 2016 on Patents, and Law Number 31 of 2000 on Industrial Design, and Government Regulation Number 36 of 2018 on Integrated Circuit Layout Design. These regulations form the legal framework for the registration, enforcement, and commercialisation of intellectual property in Indonesia.

Law No. 13/2016 on Patents grants exclusive rights to patent holders for new inventions that can be applied in industry, including the semiconductor sector. Article 20 stipulates that patent holders are obliged to make products or use processes in Indonesia to support technology transfer, investment absorption, and employment provision. Patents are granted for a period of 20 years (Article 22), providing long-term protection for innovation. In addition, Article 160 prohibits other parties from making, using, or selling patent-protected products without the patent holder's authorisation, as well as using protected processes to manufacture such goods. Violation of this provision is punishable by imprisonment of up to 4 years and/or a maximum fine of

Rp1,000,000,000.00 (Article 161), which provides strict sanctions against intellectual property rights violations and supports the creation of a safe innovation climate in Indonesia [62], [63], [64].

Law No. 32 Year 2000 on Integrated Circuit Layout Designs provides protection to integrated circuit layout designs used in the production of semiconductor chips. These layout designs are protected to prevent imitation and unauthorised use, which is important for protecting innovation in chip manufacturing. Meanwhile, Government Regulation No. 36/2018 on the Recording of Intellectual Property Licence Agreements regulates the procedure for recording intellectual property licence agreements, including licences on integrated circuit layout designs and patents. This regulation aims to ensure that licences are legally recorded and recognised by the government, which supports transparency and legal certainty in the use of licensed technology, including in the semiconductor ecosystem [63], [64].

3.4. Indonesia's Semiconductor Ecosystem Compared to Global Leaders

The semiconductor industry is highly concentrated in a few major economies. The US, the UK, Germany, China, Taiwan, Japan, and South Korea are the key players in global semiconductor ecosystem, while Indonesia currently still lagged in this field. Indonesia is still in the early stages, with limited human resources and R&D facilities. In addition, Indonesia still lacks a comprehensive regulatory structure, strong incentives, and integrated industry policies. However, Indonesia has taken positive steps, such as prioritising semiconductors under Asta Cita and Making Indonesia 4.0.

Leading Countries in the Semiconductor Ecosystem and Indonesia's Position

The semiconductor industry is a key driver of the global economy, but its contribution is highly concentrated in a few major economies. The US, the UK, and Germany are leading players in semiconductor design and innovation, while China, Japan, Taiwan, and South Korea dominate manufacturing and fabrication. Given the capital-intensive nature of the industry, only a handful of countries hold a crucial role in shaping the global semiconductor supply chain.

China's semiconductor industry is a major driver of its economy, contributing nearly one-third of global semiconductor sales and accounting for approximately 30% of China's GDP (USD 5,388 billion) [65]. In contrast, Indonesia has a minimal presence in the global semiconductor value chain, and its direct contribution to GDP remains unmeasured. However, Indonesia is a key manufacturing hub in Southeast Asia, with the manufacturing sector contributing 18.67% to its GDP in 2023 [66], While its semiconductor industry is still in its early stages, Indonesia's strong manufacturing base presents opportunities for future integration into the global semiconductor ecosystem.

China and Taiwan dominate global semiconductor exports, while Malaysia and Singapore lead in Southeast Asia, with Indonesia ranking far behind. China is the first largest exporter of semiconductor devices in the world. [67] And Taiwan was the largest export of electronic integrated circuits in the world [68]. In Southeast Asia countries, Malaysia was the largest exporter of semiconductor devices in Southeast Asia [68] and Singapore had the highest value export in electronic integrated circuits. Additionally, Malaysia will pay Arm Holdings USD 250 million over 10 years to acquire the company's chip design plans for local manufacturers [69]. Indonesia is ranked as the 27th exporter of semiconductor devices in the world [70] and the 26th exporter of electronic integrated circuits in the world [71].

China is projected to lead global semiconductor revenue by 2025, while Indonesia is expected to have the highest growth rate, alongside strong government support in key markets like South Korea, Singapore, Vietnam, and Indonesia. China is predicted to be the country with the largest revenue in the world by 2025 and Indonesia will have the highest annual growth rate (CAGR 2025-2029) [72]. Some countries also have potential because of their government support such as the South Korean government offering subsidies, tax incentives, and R&D funding; the Singapore government's commitment of USD 13.6 billion for R&D and infrastructure development, and tax incentives; the government in Vietnam providing training programmes for the semiconductor workforce. In Indonesia, the government also promotes the industry's growth with tax incentives, investment support, and a road map.

Indonesia’s R&D & Workforce Quality Compared to Global Leaders

Each country is developing its human capital and R&D in the semiconductor ecosystem, but Indonesia remains behind other countries. Indonesia is still in the early stages of industry development, with limited human resources and R&D facilities, minimal IP ownership, and a brain drain phenomenon. While global leaders like the US, China, and Taiwan invest heavily to support the semiconductor workforce and R&D, Indonesia’s efforts, such as BRIN research centres, are still catching up with more advanced countries.

TABLE 3.5. Initiatives and Challenges of Semiconductor Workforce and R&D

Country	Key Initiatives	Challenges	Strategic Actions
China	Made in China 2025 strategy prioritising Electronic Design Automation (EDA); National EDA Innovation Centre	Dependence on foreign EDA tools, limited domestic market share	Increasing domestic EDA market share, expanding R&D collaborations
Germany	"Silicon Saxony" hub with 600+ microelectronics companies; EUR 12 million “Skills4Chips” initiative	Ageing workforce, skills gap in microelectronics	Mikrotec Academy for national semiconductor education, industry partnerships
Indonesia	Science & Technology Parks (STPs), ITB labs, BRIN research centres	Limited human resource and R&D facilities, IP ownership challenges, and a brain drain phenomenon	Investment in human capital, STP expansion, research centre specialisation
Japan	Partnership with Tenstorrent to train 200 semiconductor engineers over five years	Shortage of STEM graduates compared to global peers	Focus on RISC-V chip design training, knowledge transfer from international firms
Malaysia	National Semiconductor Strategy targeting 60,000 skilled engineers; IC design expansion	Workforce retention issues, talent mismatch in E&E sector	Government-university partnerships, MIMOS Academy for workforce
Singapore	IC design training programme with NTU, SSIA, and EDB	Need for increased local R&D talent, reskilling workforce	Work-based training, PhD scholarships, reskilling mid-career professionals
South Korea	Tech Day recruitment events by Samsung and SK Hynix; Specialised university programmes	Expected shortage of 56,000 skilled workers by 2031	Expanding semiconductor degree programmes, easing recruitment policies

Country	Key Initiatives	Challenges	Strategic Actions
Taiwan	Leading global semiconductor hub with about 285 companies and 290,000+ workers; National semiconductor colleges	Increasing global demand for skilled workers	National Key Fields Industry-University Act, expansion of chip education programmes
Thailand	"Semiconductor and Advanced Electronics" workforce development project	Limited skilled workforce for the semiconductor industry	University partnerships, workforce incubation programmes
United Kingdom	Strengths in semiconductor design, IP, and compound semiconductors; Skills Dashboard to map industry demand	Shortage of STEM graduates, lack of practical industry training	Investing in STEM education, industry-based learning, and R&D in IP and system architecture
United States	CHIPS R&D programme investing USD 11 billion across four entities (NSTC, NAPMP, SMART USA, CHIPS Metrology)	High R&D costs, reliance on foreign manufacturing	Investment in advanced manufacturing, metrology, workforce training
Vietnam	National plan to train 50,000 semiconductor engineers by 2030	The labour shortage in chip design and manufacturing	Strengthening public-private R&D collaborations, policy incentives for investment

Source: Compilation from several sources by LPEM FEB UI (2025)

Indonesia's semiconductor industry remains underdeveloped compared to global leaders due to limited production scale, R&D investment, and workforce development. While countries like the US, China, and Malaysia have established integrated semiconductor ecosystems, Indonesia only has PT Infineon Technologies Batam, which focuses on assembly, testing, and packaging. **Leading nations are investing heavily on R&D, with the US allocating USD 11 billion and Taiwan prioritising workforce training, while Indonesia struggles with brain drain, minimal IP ownership, and insufficient research funding.**

Moreover, global competitors provide significant policy incentives, such as the US CHIPS Act and tax breaks in Malaysia and Singapore, while Indonesia's regulatory framework remains in its early stages. Without substantial investment in R&D, workforce development, and industrial policies, Indonesia risks falling further behind in the global semiconductor race despite its resource potential. To strengthen its semiconductor industry, Indonesia can learn from countries that have developed strategic advantages. The UK, for instance, has built expertise in semiconductor design, intellectual property development, and compound semiconductors, areas that could inform Indonesia's approach to industry growth. Additionally, the UK's Skills Dashboard, which maps industry demand to workforce development, provides a model for addressing talent shortages and ensuring alignment between education and industry needs.

Indonesia's Policy Framework Among Global Comparison

Given Indonesia's efforts in policy formulation and incentive provision to strengthen its semiconductor ecosystem, a comparative analysis of global best practices (see Box D) and the UK Semiconductor Policies and Strategic Initiatives (see Box E) offers valuable insights. These references highlight how different countries balance fiscal support, regulatory frameworks, and industry collaboration to enhance competitiveness. By learning from these strategies, Indonesia can refine its approach to ensure its semiconductor policies remain globally competitive and effectively attract investment and innovation.

Box D. Comparative Analysis of Semiconductor Policies and Incentives Worldwide

Global semiconductor policies vary across countries. The US advances through the CHIPS and Science Act, while the UK prioritises R&D and compound semiconductors. China emphasises technological autonomy with tax incentives, and Japan collaborates globally on next-generation chips. Southeast Asian nations, including Malaysia, Singapore, Vietnam, and Thailand, offer tax benefits, infrastructure, and workforce programmes. Indonesia, still in the early stages, lacks a comprehensive regulatory framework. Further details on each country's policies, including specific incentives, strategic initiatives, and their implications for industry development, can be found in Table 3.6.

TABLE 3.6. Policy and Incentive of Semiconductor Ecosystem

Country	Policy and Incentive
United States	• 2020: authorised CHIPS Act (Creating Helpful Incentives to Produce Semiconductors Act), aims to strengthen domestic semiconductor to enhance economic resilience and national security. • 2022: authorised CHIPS & Science Act, which provides semiconductor manufacturing grants, research investments, and tax credits for chip production. ○ Allocates USD 52.7 billion for semiconductor research, development, manufacturing, and workforce development. ○ Provides a 25% investment tax credit for capital costs related to semiconductor manufacturing and supporting equipment.
United Kingdom (Further details on the UK policy and regulation can be found in Box E)	• 2023: launched the National Semiconductor Strategy, which aims to strengthen the UK's position in future semiconductor technology over the next 20 years by focusing on its strengths in R&D, design, IP, and compound semiconductor technologies. ○ Launched the UK Semiconductor Infrastructure Initiative, which aims to support commercial R&D and the growth of small and medium-sized enterprises (SMEs). The initiative focuses on developing infrastructure, including expanding the UK’s “open foundry” ecosystem and improving access to chip design equipment, IP, and silicon prototyping facilities. ○ Invests an additional GBP 750 million over three financial years (2022/2023 to 2024/2025) to support high-quality teaching and the development of higher education facilities, particularly in engineering, physics, and electronics.
East Asian Countries	
China	• 2015: announced **Made in China 2025 (MIC2025)** to strengthen the domestic manufacturing sector, identified semiconductor as one of priority industries. ○ MIC2025 targets increasing the ratio of local components in the “basic core components and critical basic materials” category. The sub-policy Technology Roadmap of Key Industries had specified detailed targets for the semiconductor industry, including mass production of 16/14nm processes and set the domestic production ratio of integrated circuits (ICs).

Country	Policy and Incentive

	• August 2020: released a new policy, **the State Council Policy for Promoting High-Quality Development of the IC and Software Industry in the New Period.**
	  ○ The granting of a full corporate income tax exemption for 10 years for semiconductor manufacturers using 28nm or higher process technologies.
	• November 2020: introduced **the 14th Five-Year Plan,** which highlights the importance of autonomy in semiconductor. Committees to invest about USD 150 billion to support the development of the domestic semiconductor ecosystem.
	• 2022: distributed more than 12.1 billion yuan (USD 1.75 billion) in subsidies to 190 domestic semiconductor companies.
	  ○ Companies in the fields of packaging, testing, materials, software, and IC equipment manufacturing receive tax incentives for a certain period.
	  ○ Emphasises the importance of building a "national system" to develop core semiconductor technologies.

Japan	• 2021: announced strategies for the semiconductor and digital industries, including: (1) establishing a manufacturing base; (2) forming a next-generation technology alliance with the US; and (3) developing revolutionary future technologies.
	  ○ One of Japan's strategic steps was to **encourage TSMC** to set up an office in Kumamoto. TSMC then formed a joint venture with Sony and Denso in the form of Japan Advanced Semiconductor Manufacturing.
	  ○ Adopting a two-pronged approach to realise the mass production of next-generation semiconductors, includes the **establishment of the Leading-Edge Semiconductor Technology Centre (LSTC)** as an open research and development facility, and the **establishment of Rapidus** as a new chip manufacturer.

Taiwan	• The government has actively supported the development of industry by **providing access to essential resources such as water, electricity, and land and by offering tax incentives.** Government also **encouraged capital market to provide R&D support** through the Industrial Technology Research Institute (ITRI).
	• The **establishment of industrial parks** to create adequate infrastructure.
	• Strategic policies are aimed to **attract investment from international companies.**
	• 2023:
	  Increasing **tax breaks** from 15% to 25% for local companies' R&D investment.
	  ○
	  ○ Offering an additional 5% **tax credit** for investments of up to NT$10 billion (USD 0.3 billion) for the purchase of new equipment supporting advanced process technology.
	  ○ Increase the minimum **corporate income tax** from 12% (2023) to 15% (2025).

South Korea	• 2023: South Korean government passed the K-Chips Act with expectation to encourage more domestic investment, especially for Samsung and SK Hynix Inc, the giant chipmakers in South Korea.
	  ○ **Increases the tax credit** from 8% to 15% for large companies investing in semiconductor manufacturing facilities.
	  ○ Small and medium-sized companies will receive a **larger tax incentive** of up to 25%, up from 16% in 2023.

Southeast Asian Countries	
Country	**Policy and Incentive**
Malaysia	• 2024: The Malaysian government announced **the National Semiconductor Strategy (NSS)**, targeting an investment of RM500 billion by 2030, the development of local semiconductor companies, and the development of 60,000 skilled local workers. • Several important initiatives: infrastructure development, incentives, and workforce skills enhancement. • Key programmes: (1) the Advanced Packaging and Technology Centre to encourage innovation and collaboration; (2) MYChipStart programme to support start-ups in IC design; and (3) semiconductor industrial park. • Other incentives schemes: special tax incentives, attractive training, and matching grants for research and development (R&D).
Singapore	• Singapore has become a destination for high-value-added manufacturing investment due to its **favourable tax and regulatory environment**, as well as **investment incentives** and **competitive logistics costs.** • Amid the trade tensions between the United States and China, Singapore's Economic Development Board (EDB) is seeking to attract a significant share of investment in semiconductor assembly and integrated circuit design.
Vietnam	• The **Vietnamese** government has developed **a comprehensive legal framework to attract and regulate semiconductor investment.** • **Key laws:** (1) Law on Investment 2020, forms the basis for FDI; (2) High Technology Law, regulates incentives and requirements for high-tech companies; (3) Enterprise Law, sets out rules for establishing and operating businesses; and (4) Specific Semiconductor Industry Regulations, regulates certification, technology transfer, and compliance with environmental regulations. • Vietnam has also developed **dedicated parks** to support semiconductor manufacturing, equipped with advanced infrastructure and tailored support services. • **Key parks:** (1) Saigon Hi-Tech Park in Ho Chi Minh City, home to Intel’s largest assembly and testing facility; (2) Hoa Lac Hi-Tech Park in Hanoi, focused on high-tech R&D and manufacturing; and (3) Danang Hi-Tech Park in Danang, which is developing as a hub for semiconductor-related industries.
Thailand	• 2024: Thailand’s Semiconductor Board approved **the framework of Thailand’s National Semiconductor Strategy.** • Target: to prepare for a minimum of THB500 billion (about USD 15 billion) FDI semiconductor by 2029. • Strategy to develop a skilled workforce: training, upskilling and retraining for a total of over **86,000 people** to meet the sector’s demand, including **1,400 master’s and PhD researchers**, through a talent development scheme.

Country	Policy and Incentive
Indonesia	• Indonesia currently has not yet had regulations that comprehensively regulate all semiconductors aspects from upstream to downstream. Several general policies which may have an impact on semiconductors: fiscal incentives (Government Regulation No. 78/2019 and Regulation of the Minister of Finance No. 11/2020), industrial area (Government Regulation No. 142/2015). • The government has also designated semiconductors as a **national priority sector** in various strategic documents, including **Asta Cita and Making Indonesia 4.0**, although its implementation is still more focused on downstream natural resources. • The government has formed a **Semiconductor Ecosystem Task Force** (The Decree of the Coordinating Minister for Economic Affairs on 16/2024). ○ Aim to prepare semiconductor industry roadmap and to coordinate cross-sector policies related to investment, technology, employment, and infrastructure, as well as to overcome major challenges such as limited skilled labour, energy water needs, and infrastructure.

Source: Compilation from several sources by LPEM FEB UI (2025)

Box E. The UK Semiconductor Policies and Strategic Initiatives

Over the past 70 years, the UK's semiconductor industry has experienced growth, yet it has remained behind the US and Europe. The UK government has yet to significantly expand the country's semiconductor ecosystem despite various efforts over the past few decades. The UK Government launched the National Semiconductor Strategy in 2023 to boost growth, resilience, and security. Historical perspectives on semiconductor strategies in the UK can be seen in Annex F.

In 2023, the UK government, through the Department for Science, Innovation, and Technology, launched a twenty-year National Semiconductor Strategy. The strategy focuses on three objectives: (1) growing the domestic sector by leveraging strengths in design, R&D, IP, and compound semiconductors; (2) the UK's resilience amidst supply chain disruption; and (3) protecting national security. This vision is expected to drive technological innovation, create jobs, and strengthen the UK's global competitiveness. The key focus areas for each objective are explained below [73].

Domestic semiconductor growth is strategic for its economy amid rising global demand. Through the National Semiconductor strategy, the UK aims to enhance expertise in chip design and IP, lead in compound semiconductors, and accelerate research in advanced technologies. To achieve this, the UK government will focus on three key areas: R&D, infrastructure, and skills development. Over the past decade, R&D support has been provided by the Engineering and Physical Sciences Research Council (EPSRC) and Innovate UK with funding for SMEs. To accelerate, the government will invest up to GBP 200 million from 2023 to 2025 and GBP 1 billion over the next decade to address skill gaps, boost manufacturing competitiveness, support doctoral research, and offer tax incentives for SMEs.

In response to global supply chain disruptions, the UK government aims to strengthen domestic resilience, including in the semiconductor sector. Measures include preparing the semiconductor industry, protecting critical sectors, and publishing guidance, as well as establishing a government-industry forum to mitigate semiconductor supply chain disruptions. The UK will pursue both domestic actions (i.e., contingency planning and future needs reviews) and international actions (i.e., the UK's Asia Pacific Digital Trade Network and bilateral cooperation). Additionally, the UK will focus on protecting its technological assets and enhancing the UK's hardware capacity to safeguard national security.

CHAPTER 4

Foresight of Indonesia's Semiconductor Ecosystem: Identifying Trends and Overcoming Challenges

Indonesia's semiconductor ecosystem is shaped by multiple external and internal factors that influence its growth potential. PESTEL analysis highlights key drivers, such as government commitment, investment incentives, economic stability, workforce availability, and increasing digital adoption, while also pointing to regulatory challenges, weak infrastructure, and limited R&D capabilities as barriers. Market trends show rising global and domestic demand, particularly in EVs, AI, and digital technology, yet Indonesia's export-driven industry and underdeveloped local supply chain limit its competitiveness. A gap analysis reveals critical weaknesses, including skill shortages, policy misalignment, and business leadership gaps, which hinder industry growth. However, opportunities exist in global supply chain diversification, foreign investment interest, and the growing need for semiconductors in key sectors.

As Indonesia seeks to strengthen its position in the global semiconductor landscape, a forward-looking approach is essential to anticipate emerging trends and address critical challenges. Building upon the discussion of Indonesia's semiconductor industry landscape in the previous chapter, this section shifts focus towards identifying key opportunities and obstacles that shape the country's semiconductor development. By leveraging strategic foresight, Indonesia can position itself as a competitive player in the semiconductor value chain.

Indonesia's semiconductor ecosystem is perceived by stakeholders to be influenced by multiple external and internal factors that determine its growth potential. A comprehensive PESTEL (Political, Economic, Social, Technological, Environmental, and Legal) analysis provides insights into these influences. In addition to these factors, domestic and global semiconductor trends also influence Indonesia's semiconductor prospects. Furthermore, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis provides a clearer picture of Indonesia's semiconductor industry's competitive positioning. A well-defined strategy that mitigates weaknesses while leveraging opportunities will be crucial in shaping Indonesia's semiconductor ecosystem.

To further elaborate on the **foresight of Indonesia's Semiconductor Ecosystem, this chapter is structured as follows:**

- **Chapter 4.1 explores emerging trends and opportunities that could drive Indonesia's semiconductor sector forward.** It begins with an **analysis of PESTEL and market trends**, examining the political, economic, social, technological, environmental, and legal factors influencing the industry, along with key domestic and global market trends. The discussion then identifies high-potential sectors where Indonesia's semiconductor industry can expand and thrive, highlighting areas of comparative advantage and strategic importance.

- **Chapter 4.2 focuses on the major challenges hindering Indonesia's semiconductor growth.** It includes a **gap analysis**, assessing the disparity between the current state of the industry and its desired future while identifying the most pressing barriers to development. These challenges include infrastructure limitations, skill shortages, weak domestic demand, and policy misalignment, all of which must be addressed to create a stronger ecosystem.
- **Chapter 4.3 provides a strategic perspective, this section evaluates the strengths, weaknesses, opportunities, and threats (SWOT) shaping Indonesia's semiconductor industry.** The analysis highlights Indonesia's advantages, such as its demographic bonus and natural resource potential, while also addressing structural weaknesses, external opportunities, and potential threats from global competition and geopolitical risks. This section provides key insights for policymakers and industry stakeholders to develop strategies that enhance Indonesia's position in the global semiconductor landscape.

Each section builds upon the foundational understanding of Indonesia's semiconductor industry landscape established in the previous chapter, paving the way for informed decision-making and sustainable growth.

4.1. Trends and Opportunities for Growth in Indonesia's Semiconductor Ecosystem

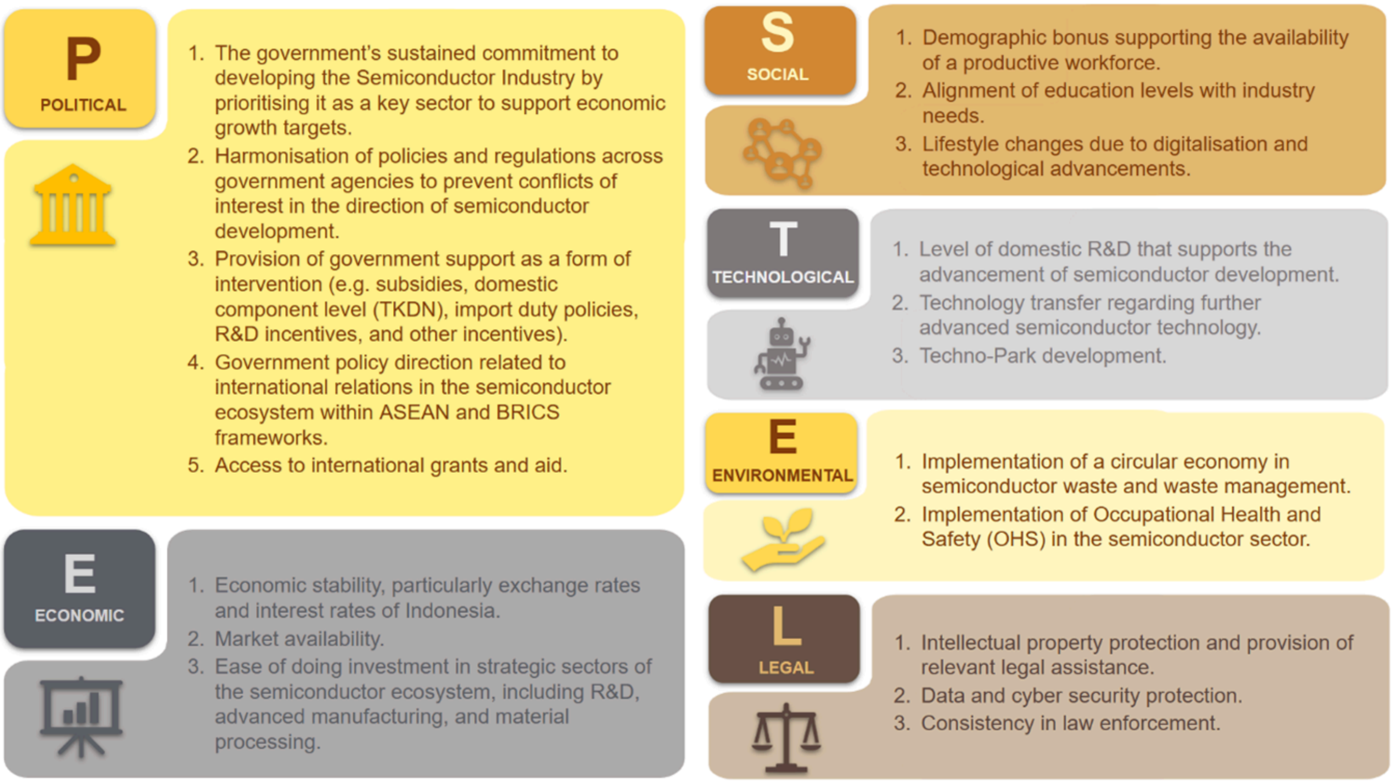
The government's growing initiatives and digital adoption drive the development of the semiconductor ecosystem, yet regulatory and infrastructure challenges persist. While growing demand for digital technology supports economic expansion, weak local supply chains limit competitiveness. Short-term opportunities lie in ATP and chip design, fabrication is viable, but material processing remains constrained by technological limitations.

Analysing PESTEL and Market Trends

PESTEL

The PESTEL analysis is conducted to identify factors that may influence the development of the semiconductor industry in Indonesia, considering both domestic and global conditions.

FIGURE 4.1. PESTEL Analysis on Semiconductor Ecosystem in Indonesia



Source: Consultative Workshop conducted by LPEM FEB UI (2025)

1. Politics

a. **The government's sustained commitment to developing the semiconductor industry by prioritising it as a key sector to support economic growth targets. This industry requires high investment, making government initiatives and long-term policy stability crucial for its sustained development.** Inconsistent policies could lead to sunk costs and deter investors, emphasising the need for clear regulatory frameworks and sustained governmental support. The prioritisation of downstream and industrialisation aligns with Asta Cita point 5, which focuses on independence increasing domestic value-added in raw materials and manufacturing. By positioning semiconductors as a national priority, the government can integrate this sector into key industrial policies.

b. **Harmonisation of policies and regulations across government agencies to prevent conflicts of interest.**
Lack of coordination between government institutions can result in overlapping regulations, bureaucratic inefficiencies, and delays in policy implementation. To address this, the Semiconductor Ecosystem Preparation Task Force is essential for enhancing inter-institutional coordination, integrating policies, strengthening global engagement, and attracting FDI (see Table 3.4). Establishing a clear governance structure will ensure policy consistency for semiconductor ecosystem development.

c. **Provision of government support as a form of intervention (e.g. subsidies, local content requirement (TKDN), import duty policies, R&D incentives, and other incentives).**
The incentives function similarly to public goods, requiring government intervention to ensure policies affect the entire ecosystem rather than individual businesses. If left solely to the private sector, companies will naturally prioritise profit-driven strategies that may not align with the broader goal of strengthening Indonesia's semiconductor ecosystem. This approach is consistent with global best practices, where leading semiconductor-producing nations provide fiscal and nonfiscal incentives to drive industry growth (see Box D).

For instance, **strengthening the TKDN policy would encourage local industry participation, a crucial step as Indonesia's semiconductor sector is still in its early stages.** Another key area is importing duty incentives, as the current tax structure makes it cheaper to import finished goods than semiconductor components, discouraging domestic production. Therefore, targeted import duty reductions are needed to lower production costs. Additionally, Indonesia could revise and clarify LARTAS (*Larangan Terbatas*/Limited Prohibition) policies related to semiconductor component imports to support this industry.

d. **Government policy direction related to international relations.**
Strengthening strategic partnerships with global-leading semiconductor ecosystems is essential for technology transfer, R&D collaboration, workforce development, supply chain resilience, and investment attraction. Indonesia can enhance its collaboration within the ASEAN network, leveraging the region's growing semiconductor manufacturing base, shared economic interests, and existing regional trade agreements to facilitate market access. With its vast nickel reserves, Indonesia has a strategic advantage in expanding partnerships with the BRICS bloc, attracting investments and collaboration in the semiconductor ecosystem. However, geopolitical tensions must be carefully navigated, as the US has adopted a tough stance on trade with BRICS countries, potentially imposing tariffs or restrictions that could impact Indonesia's semiconductor trade and investment landscape.

e. **Access to international grants and aid.**
The high cost of semiconductor components and infrastructure development, combined with fiscal constraints, makes international grants and foreign aid crucial for Indonesia to build a competitive semiconductor ecosystem. Indonesia previously received a 500 million USDITSI FUND injection from USAID, but the programme has faced continued challenges due to US-imposed restrictions on geopolitical considerations. Indonesia must secure diverse funding sources, including multilateral development funds and foreign investment incentives, to secure long-term funding.

2. Economic

a. **Economic stability, particularly exchange rates and interest rates.**
Stable monetary policies and financial predictability are crucial for attracting and retaining investment in the sector. The volatility of exchange rates significantly impacts semiconductor production costs in Indonesia, as many essential components are imported. A fluctuating exchange rate increases uncertainty in pricing, making it difficult for manufacturers to manage expenses effectively. A weaker rupiah raises the cost of imported raw materials, reducing competitiveness in the global market. Conversely, a stronger rupiah can make exports less attractive, limiting Indonesia's role in the international semiconductor supply chain.

Similarly, interest rate instability influences investment in semiconductor manufacturing. High and unpredictable interest rates discourage long-term investments, as they increase borrowing costs for capital-intensive projects such as chip fabrication. Additionally, stock market fluctuations, influenced by macroeconomic factors, can impact investor confidence, reducing the availability of funding for semiconductor-related ventures.

b. **Market availability.**
The domestic market plays a pivotal role in determining the viability of Indonesia's semiconductor industry. A competitive and growing demand for electronic devices, EVs, and industrial automation can drive the expansion of the local semiconductor ecosystem (see Chapter 1.1). If domestic demand is high, manufacturers have a greater incentive to establish production facilities in Indonesia, reducing reliance on imports and strengthening the supply chain.

However, if the market remains underdeveloped or lacks purchasing power, semiconductor production may struggle to scale, leading to stagnation. Without a well-established market, companies may be forced to rely heavily on exports, which exposes them to global competition and demand fluctuations. Government policies that encourage domestic adoption of advanced technology, such as incentives for EVs and smart manufacturing, can help create a stable market for semiconductors.

c. **Ease of doing investment**
Investment regulations in Indonesia remain complex, with bureaucratic inefficiencies and legal uncertainties that deter investors. Although the government has introduced the Online Single Submission (OSS) system to simplify business licensing, persistent corruption and unauthorised levies *(pungutan liar)* imposed by local interest groups *(organisasi kemasyarakatan lokal)* pose obstacles. These unofficial fees increase operational costs and discourage businesses from expanding, particularly in sectors requiring extensive permits and approvals.

Moreover, **inconsistent policy enforcement and rent-seeking practices further erode investor confidence.** Businesses frequently encounter unpredictable regulatory changes and local interventions that disrupt planning and execution, especially in capital-intensive industries like semiconductor manufacturing. Addressing these issues through stricter law enforcement, regulatory transparency, and enhanced governance mechanisms is crucial to improving Indonesia's investment climate and attracting long-term foreign direct investment.

3. Social

a. **Demographic bonus[9] supporting the availability of a productive workforce.**
Indonesia's demographic bonus, characterised by a relatively young median age, provides a significant advantage in workforce availability for the semiconductor industry (see Box F). A large working-age population can drive economic productivity, particularly if they are equipped with relevant skills and employment opportunities. This demographic shift creates a substantial labour pool, reducing dependency on foreign talent and supporting long-term industry sustainability.

b. **Alignment of education levels with industry needs**
A key challenge in Indonesia's semiconductor ecosystem is the misalignment between education and industry requirements. While the country produces many vocational and undergraduate graduates, specific semiconductor-related skills remain scarce (see Chapter 1.2). The only known institution with a semiconductor-focused curriculum, Polibatam, has yet to attract significant student interest, limiting the local supply of skilled professionals.

Furthermore, **skilled workers often seek employment abroad due to higher wages, leading to a talent drain that exacerbates the skills gap domestically.** Semiconductor technology is inherently complex, requiring specialised knowledge that is not yet widely available in Indonesia. The lack of skilled professionals, coupled with limited domestic job opportunities, restricts the growth of a competitive local semiconductor industry.

c. **Lifestyle changes due to digitalisation and technological advancements**
The rapid adoption of new technologies is transforming consumer behaviour in Indonesia, fostering a dynamic market for semiconductor-based products. Increased access to smartphones, smart devices, and digital services has accelerated demand for advanced semiconductor components. As digitalisation progresses, consumers are adopting new technologies at a faster rate, stimulating market expansion in electronics, AI, and automation.

Moreover, shifting societal trends contribute to sustained semiconductor demand. Consumer preferences for electronic gadgets, smart appliances, and automotive advancements drive the need for a robust semiconductor supply chain. While Indonesia currently lacks a front-end and back-end semiconductor manufacturing ecosystem, digitalisation presents an opportunity for industry growth. Government recognition of digitalisation's role in economic development could lead to policy support that strengthens local semiconductor production and supply networks. However, the consumptive nature of Indonesia's digital lifestyle could be both a strength and a weakness, while it ensures market demand, over-reliance on imports may hinder efforts to develop a self-sufficient semiconductor industry.

9 Demographic bonus occurs when a country's population structure shifts, resulting in a larger proportion of the population being in the productive age (typically 15-64 years old) compared to the non-productive age (children and the elderly).

4. **Technology**

   a. **Level of domestic R&D that supports the advancement of semiconductor development.**
   A strong domestic R&D system is essential for semiconductor development, as this industry heavily relies on innovation. Indonesia is expanding its semiconductor R&D efforts through government, private sector, and university initiatives; however, challenges remain in commercialisation (see Chapter 1.4). To address this, developing technology incubators is crucial for nurturing startups, commercialising existing research, and accelerating the creation of new industries based on locally developed semiconductor technologies.

   b. **Technology transfer in advanced semiconductor technology, particularly in AI-integrated chips, advanced lithography, and high-performance computing.**
   Given that Indonesia's semiconductor ecosystem is still in its early stages, international collaboration plays a role in accelerating its development. Knowledge sharing and capacity building are essential to bridge the technological gap and enhance local expertise. Technology transfer in advanced semiconductor fields, such as AI-integrated chips, advanced lithography, and high-performance computing, can be facilitated through joint ventures, licensing agreements, and research partnerships. These collaborative efforts not only provide access to cutting-edge innovations but also help develop a skilled workforce capable of supporting a more competitive domestic semiconductor industry.

   c. **Technopark development.**
   Technoparks are essential for the semiconductor ecosystem, as this sector requires specialised infrastructure and dedicated support systems that differ from other industries. Key requirements include an uncontaminated and abundant water supply and a stable and high-capacity power system, both of which are critical for semiconductor fabrication processes. Technopark development must strategically align with incubators, industry stakeholders, and research institutions to support innovation and commercialisation.

5. **Environment**

   a. **Implementation of a circular economy in semiconductor waste and waste management.**
   The circular economy in the semiconductor industry involves reusing and recycling semiconductor materials to minimise waste and optimise the use of raw materials. This includes electronic waste management and net-zero initiatives to reduce carbon emissions. However, semiconductor waste, including hazardous electronic waste (B3), can pose significant environmental and health risks during production and at the end of a product's life cycle. One of the challenges is the lack of transparency in the industry, as manufacturers do not always disclose harmful materials used in production, making effective monitoring and regulation essential.

b. **Implementation of Occupational Health and Safety (OHS) in the semiconductor sector.**
OHS is essential due to the industry's reliance on hazardous chemicals, where exposure to toxic substances, improper waste handling, and inadequate safety protocols can pose serious risks to worker health, environmental sustainability, and overall production efficiency. OHS training in vocational schools (SMK) is limited or not yet effectively implemented, highlighting the need for stronger education and workforce preparedness in semiconductor waste management.

6. Legal

a. **Intellectual property protection and provision of relevant legal assistance.**
The protection of IP is crucial for Indonesia's semiconductor industry, as innovation and technological advancement rely on a secure and well-regulated IP system (see Chapter 1.3). Currently, Indonesia is still working towards establishing a competent IPR, which remains a key concern for international investors. Foreign stakeholders often perceive Indonesia's IP protection system as weak, making them hesitant to transfer technology or invest in semiconductor research and development. According to the 2024 International IP Index by the U.S. Chamber of Commerce, Indonesia ranks 49th out of 55 countries in intellectual property protection, trailing behind other ASEAN nations such as Thailand (43rd), Vietnam (40th), Malaysia (27th), and Singapore (12th) [74]. Improved IP protection, supported by relevant legal assistance, is essential to attract foreign partnerships, safeguard local innovations, and enhance Indonesia's position in the global semiconductor value chain.

b. **Data and cyber security protection.**
As Indonesia advances in semiconductor development, data and cybersecurity protection are critical to ensuring industry resilience. Weak security measures expose businesses to risks like IP theft, industrial espionage, and supply chain breaches, discouraging foreign investment. Strengthening regulatory frameworks and aligning with global cybersecurity standards will enhance trust and support Indonesia's integration into the global semiconductor supply chain.

c. **Consistency in law enforcement.**
Legal consistency is essential for fostering a stable and predictable business environment in the semiconductor sector. Inconsistent law enforcement creates uncertainty for investors, particularly in areas such as IP rights, contract enforcement, and investment protection. Strengthening regulatory coherence and ensuring uniform legal application will enhance investor confidence and Indonesia's competitiveness in the global semiconductor industry.

Market Trends

Market trend analysis is conducted to understand the development of the semiconductor market domestically and globally.

FIGURE 4.2. Market Trends Analysis on Semiconductor Ecosystem in Indonesia

	DOMESTIC	GLOBAL
GROWTH	1. EV's demand growth. 2. Growth in demand for electronic household appliances (although not applicable to all devices). 3. The growing trend of digital lifestyle. 4. Increase in the number of applications for data center construction permits from the government.	1. EV's demand growth. 2. Growth in demand for electronic household appliances (although not applicable to all devices). 3. The growing trend of digital lifestyle. 4. The massive development of advanced technology (such as AI, robotics, big data, etc).
COMPETITION	1. There is no competition between companies because the market is still limited. 2. There is a potential increase in the number of foreign investments due to geopolitical condition.	1. The semiconductor competition among major player countries persists, although the key players remain largely unchanged.
INNOVATION	1. Innovation is showing growth, yet it is still constrained by several factors (investment, technology, regulatory challenges).	1. There has been a significant increase in innovation, where companies are even competing to create innovations.
COMPARATIVE ADVANTAGES	1. There are natural resource reserves for semiconductor raw materials; however, this potential has not yet become a comparative advantage due to its suboptimal utilisation. 2. Demographic bonus and low wages allow for cost efficiency compared to other countries. 3. Large population, providing a wide market potential.	1. Advanced technology and capital availability.
ROUTES TO MARKET	1. Indonesia's semiconductor ecosystem remains export-oriented, as the value-chain ecosystem has not yet developed due to the absence of strong domestic demand.	1. A complete supply chain ecosystem has been established.

Source: Consultative Workshop conducted by LPEM FEB UI (2025)

1. **Growth**
   The semiconductor demand market has experienced growth in recent years, except during the pandemic. This market is driven by rising demand in the electronics and automotive industries due to lifestyle changes and increasing consumer spending (see Chapter 1.1). Steady revenue growth enables greater allocation of funds to technology-based products, creating increased demand in related sectors. Domestically, the growth trend of the semiconductor ecosystem is also influenced by the increase in applications for data centre construction permits to the government. In Indonesia, by 2025, there will be 137 data centres spread across the region, including Batam, Surabaya, Bandung, Medan, Yogyakarta, and Pekanbaru [75] Indonesia's data centre is also the second largest in ASEAN, with a capacity of 202 MW [76]. As the AI era develops, the need for computing data centre capacity that relies on semiconductors is increasing [77].

2. **Competition**
   Competition in the local semiconductor industry is still limited due to the market not being fully developed. However, geopolitical shifts and global economic dynamics open opportunities to increase competition in the semiconductor industry through increased foreign direct investment in Indonesia. At the global level, geopolitical dynamics, especially the competition between major players in the US and China, also affect the semiconductor industry. Competition for investment is increasingly intense, with countries such as Vietnam successfully attracting more investment thanks to its proximity to China. Vietnam's geographical position provides advantages in terms of market access and a more efficient supply chain. Meanwhile, Taiwan is also a key player with its close relationship with the United States, which supports investment flows through technology and trade cooperation.

3. **Innovation**
   Product and service innovation in the domestic market continues to increase, but much of it does not result from local R&D activities. Instead, it originates from parent companies operating globally, while domestic entities play a greater role in implementing and adapting the innovation results to local market needs. At the global level, the innovation competition is increasingly massive, with large companies continuing to lead the direction of product development based on changing consumer preferences and technological advances.

4. **Comparative Advantages**
   Indonesia's comparative advantage in the semiconductor industry can be represented in terms of natural and human resources. The reserves of natural resources for semiconductor raw materials are considerably significant (see Box A); however, this potential has not been able to provide a comparative advantage as its utilisation is still limited. In addition, in terms of human resources, Indonesia has supporting factors including demographic bonus and relatively low wage levels, which can increase cost efficiency compared to other countries. Meanwhile, global market trends show that other countries are more technologically advanced and have greater access to capital, enabling them to build a more integrated and internationally competitive semiconductor ecosystem.

5. **Route to Market**
   Indonesia's semiconductor industry struggles to fully leverage domestic market opportunities due to its underdeveloped value chain ecosystem. The fragmented structure of the industry, where each segment operates independently, prevents seamless integration across production stages, making it difficult for domestic manufacturers to meet local demand. This also hinders the domestic industry from establishing a sustainable production cycle. As a result, companies like Infineon mostly meet international demand and export their products (see Box B). Global market trends, however, demonstrate a more developed state, with ecosystems for semiconductor supply chain that have been well-established and integrated across various nations. In the future, Indonesia is expected to play a role by joining the ecosystem.

Key High-Potential Sectors for Indonesia's Semiconductor Growth

Based on in-depth stakeholder interviews, PESTEL analysis, and market trend projections, Indonesia has several opportunities to develop its semiconductor industry.

Chip design is Indonesia's strongest starting point in semiconductor development. The country already has a growing number of experts and businesses engaged in chip design, supported by universities and research institutions. Compared to other semiconductor production stages, chip design has lower barriers to entry, making it a more viable early-stage focus. However, continued human capital development is essential to meet the sector's demand for highly skilled labour. Given current PESTEL conditions and market trends, stakeholders see this area as an accessible and promising entry point for Indonesia's semiconductor industry.

In addition to chip design, Indonesia has strong potential to expand its role in backend semiconductor production, particularly in ATP. Expert interviews suggest that ATP is well-suited to Indonesia's demographic profile, as it is more labour-intensive than wafer fabrication. Companies like Infineon have already established ATP operations in Batam, generating employment and integrating Indonesia into the global semiconductor supply chain. Furthermore, ATP involves supporting technologies such as packaging and testing, which create multiplier effects across related industries. A robust ATP sector could serve as a foundation for attracting future investments in higher-value semiconductor manufacturing.

In the medium to long term, Indonesia could also leverage semiconductor-related products that require lower production costs and technological complexity. Optoelectronics, while not as lucrative as integrated circuits, have broad industrial applications. Developing components like light-emitting diodes (LEDs) could be a practical entry point, given their widespread use in household appliances, urban farming, and automotive lighting, including LiDAR for autonomous vehicles. Additionally, Indonesia could explore sensor and actuator manufacturing, essential in industries such as healthcare, where they are used in cancer detection, virus testing, and blood analysis. While not as high-profile as logic chips, these components have strong market potential and require less capital investment, making them a strategic medium-to-long-term focus for Indonesia's semiconductor industry.

The complexity and high costs of wafer fabrication make it a rather challenging stages for Indonesia to enter. Experts acknowledge that establishing fabrication plants requires significant investment, as this stage accounts for approximately 50% of total chip production costs. The need for highly sterile environments and advanced manufacturing processes further adds to the challenges. However, Indonesia's abundant raw materials could reduce logistics costs, potentially making lower-end wafer production (higher-nanometre wafers) a viable niche. These wafers, which use older, more cost-effective technology, remain in demand for automotive, consumer electronics, and military applications. While this stage is not feasible in the short or medium term, it may become an opportunity in the longer run.

4.2. Indonesia's Critical Challenges in Semiconductor Development

Despite having the potential for growth, Indonesia's semiconductor industry faces key policy and regulatory challenges that hinder its growth and competitiveness. The absence of a comprehensive national strategy has led to fragmented initiatives and uncertainty among investors, particularly in the absence of clear incentives and regulatory guidelines. Human capital constraints, including a shortage of skilled professionals and limited industry-academia collaboration, further impact the sector's development. Infrastructure limitations, such as high electricity costs and insufficient industrial support systems, add to the challenges of establishing a competitive semiconductor ecosystem. Additionally, the absence of a structured research collaboration framework weakens Indonesia's semiconductor R&D ecosystem, limiting effective partnerships between academia, government, and industry, which in turn hampers innovation and technology adoption.

Challenges in Policy and Regulation

Indonesia's semiconductor industry faces several policy and regulatory challenges that hinder its growth and competitiveness. The absence of a clear national strategy, weak investment incentives, and regulatory uncertainties have created an environment that is less attractive to investors. Additionally, issues related to knowledge transfer, intellectual property protection, and dependence on foreign technology further limit Indonesia's ability to develop a robust semiconductor ecosystem.

1. **Absence of a clear national strategy and coordinated leadership structure**
   Indonesia's semiconductor industry faces a dual challenge: the absence of a long-term, integrated national strategy, and a lack of a dedicated coordinating body to drive it. While various stakeholders, including ministries, agencies, and private sector players, have formulated individual plans, there is no unified framework aligning investment priorities, workforce development, R&D, supply chain enhancement, and infrastructure planning. This fragmentation has led to uncoordinated efforts and inefficiencies. Although a semiconductor task force was established to align strategies and develop a national roadmap (see Chapter 1.2), industry interviews suggest that progress has been limited due to a lack of strategic focus, whether on design, assembly, testing, and packaging (ATP), or both. The task force's momentum was further disrupted by recent government transitions, leading to leadership gaps and delays in policy continuity. Moreover, the absence of a central coordinating institution has contributed to disconnects between policy and industry needs, resulting in conceptual rather than actionable initiatives, persistent regulatory barriers, and bureaucratic delays that deter foreign investment. Without a stable and empowered institutional mechanism to lead the sector, Indonesia risks continued fragmentation and missed opportunities in the global semiconductor landscape.

2. **Investment uncertainty and barriers to growth**
   Uncertainty in Indonesia's semiconductor investment landscape remains a barrier to industry development. The absence of a clear national strategy, coupled with a lack of market mapping and regulatory clarity, has undermined investor confidence. Semiconductor manufacturing requires substantial long-term capital, and without predictable policies, reliable data on market potential, and strong government commitments, investors are reluctant to commit. Frequent regulatory changes, bureaucratic inefficiencies, and the absence of a competitive incentive framework further compound this hesitation. Unlike neighbouring countries that offer targeted tax benefits, subsidies, and clear guarantees, Indonesia has yet to provide similar assurances. Industry stakeholders have expressed concern that unless these foundational issues are addressed, Indonesia will continue to struggle in attracting high-tech manufacturing investment and unlocking the sector's full growth potential.

3. **Weak investment incentives**
   Compared to countries such as Malaysia and Vietnam, Indonesia's investment incentives remain less attractive. Existing tax incentives, such as tax holidays, do not sufficiently appeal to investors who seek more comprehensive incentive packages. Additionally, Indonesia lacks dedicated semiconductor industrial clusters or techno-parks, making it difficult for investors to justify long-term commitments. Without a stable and predictable investment environment, semiconductor firms may continue to prioritise other markets over Indonesia.

4. **Ambiguous investment screening policies**
While foreign investment in semiconductor wafer production is permitted, restrictions exist on components related to national defence. However, the regulatory framework lacks precise definitions of what constitutes defence-related semiconductor technology, leading to uncertainty among investors [78]. Industry experts interviewed stated that inconsistent enforcement of these regulations has created additional challenges, with companies uncertain about which aspects of semiconductor manufacturing and design are subject to restrictions. Establishing clearer regulatory guidelines would enhance investor confidence and facilitate greater participation from international semiconductor firms.

5. **Import and export regulations**
The complexity of Indonesia's import and export regulations presents a barrier to the growth of the semiconductor industry. The sector requires a streamlined and efficient customs process that accommodates the high-speed supply chain demands of semiconductor manufacturing. However, existing procedures remain slow and administratively burdensome, creating delays in the movement of essential materials and components. Additionally, a lack of expertise among customs officers, particularly in the classification of semiconductor-related goods, often leads to misclassification, further prolonging processing times and increasing costs for businesses. Without a differentiated and expedited customs framework tailored to the industry's needs, companies face increased operational costs and supply chain disruptions, ultimately reducing Indonesia's competitiveness in the global semiconductor market.

6. **Lack of a structured knowledge transfer mechanism**
At present, there is no structured mechanism to encourage foreign companies to share expertise with local professionals. This has resulted in a skills gap that hinders the country's ability to develop a self-sufficient semiconductor ecosystem [78]. Industry stakeholders emphasised that concerns over intellectual property (IP) protection further discourage foreign firms from transferring advanced semiconductor technology to Indonesia. Weak enforcement of IP regulations increases the risk of intellectual property theft, making foreign companies reluctant to invest in research and development collaborations within Indonesia. Additionally, the lack of clear legal recourse in cases of IP infringement exacerbates investor concerns, as companies fear losing proprietary semiconductor designs to unauthorised third parties. This situation has resulted in Indonesia being overlooked as a destination for high-value semiconductor research projects, further widening the country's technological gap. Additionally, international export restrictions on high-end semiconductor technology create further challenges, as Indonesia remains dependent on foreign firms for advanced knowledge and equipment. These barriers collectively limit Indonesia's ability to develop domestic semiconductor capabilities and integrate into the global supply chain.

Challenges in Human Capital

One of the most pressing challenges in Indonesia's semiconductor industry is the shortage of skilled professionals. Despite ongoing efforts to enhance workforce development, significant gaps remain in education, training, and industry linkages.

1. **Shortage of skilled semiconductor professionals**
   The shortage of skilled semiconductor professionals is one of the pressing challenges. According to [79], Indonesia has only 2,671 engineers per million inhabitants, lower than Malaysia (3,333), China (3,380), and Vietnam (9,037). This talent gap limits Indonesia's ability to expand its semiconductor capabilities, particularly in the areas of design and manufacturing. Companies struggle to find qualified local talent and often turn to foreign professionals, driving up costs and reducing long-term competitiveness. In an interview, a semiconductor expert emphasised that even countries like Taiwan and China, which have advanced semiconductor industries, still experience talent shortages, highlighting the scale of Indonesia's challenge. Additionally, there is a lack of structured programmes to attract and retain Indonesian semiconductor professionals who have established careers abroad, making it difficult to reverse the brain drain issue.

One initiative aimed at addressing the skills gap is the establishment of the ICDec. ICDeC has implemented training programmes, including collaborations with Polytron and MBKM internships, to provide hands-on experience in semiconductor design. Additionally, ICDec has facilitated access to semiconductor design software by pooling resources among universities, reducing the cost barrier for students and researchers. However, despite these efforts, ICDec faces financial and operational constraints, as most of its activities rely on voluntary contributions from faculty members rather than sustained government or industry funding.

2. **Weak alignment between university curricula and industry needs**
   The disconnect between universities and the semiconductor industry further exacerbates the talent shortage. Many academic programmes continue to emphasise traditional electrical engineering coursework rather than specialised semiconductor training. An industry expert noted that graduates often lack hands-on experience in semiconductor fabrication and design due to weak collaboration between universities and private companies. Unlike Taiwan, where universities work closely with major semiconductor firms like TSMC, Indonesia's academic institutions largely operate in isolation from industry demands. Although BRIN provides open access to research infrastructure, university programmes often fail to integrate practical semiconductor training, leaving graduates unprepared for the workforce. Furthermore, the absence of a standardised competency certification for IC design limits the global employability of Indonesian graduates.

3. **Challenges in semiconductor-focused education and training**
   Indonesia's broader education system remains misaligned with the semiconductor industry's needs. A representative from a government research institution stated that most universities offer only limited coursework in semiconductor design, with few credit hours dedicated to the subject. While institutions like ITB and Polytechnic Batam have introduced semiconductor-related programmes, these remain insufficient to meet the industry's growing demand for skilled professionals. Additionally, semiconductor-specific training requires access to licensed software and laboratory equipment, both of which are expensive. A representative from the industry noted that Indonesian universities currently lack access to key semiconductor design software due to prohibitive licensing costs. Without exposure to industry-standard tools, graduates enter the workforce unprepared for semiconductor roles. Some industry experts pointed out that government-led investment in training facilities and licensing agreements would be essential to ensure Indonesian engineers can compete with graduates from other semiconductor-producing countries.

4. **Talent retention and brain drain**
   Indonesia also faces challenges in talent retention, as many of its top engineering graduates seek employment abroad. An interview with an industry stakeholder revealed that Taiwan, China, and Malaysia actively recruit Indonesian engineers due to their strong technical skills and lower labour costs compared to local talent in those countries. Without competitive wages and career opportunities, Indonesia may continue to lose its best talent to foreign markets, further exacerbating the human capital gap. In addition, the semiconductor industry in Indonesia is perceived as offering fewer financial rewards compared to careers in IT and digital business, further discouraging students from pursuing semiconductor-related degrees.

Challenges in Infrastructure

The development of Indonesia's semiconductor industry is also constrained by various infrastructure-related challenges. These limitations affect the entire value chain, from raw material processing to manufacturing, logistics, and research capabilities.

1. **Limited domestic processing of raw materials**
   Despite having abundant raw materials such as silica sand and bauxite, the country lacks the technology and facilities to refine these materials to the required purity levels for semiconductor production [80] According to an industry expert interviewed, Indonesia primarily exports raw silica instead of refining it into high-purity silicon, resulting in lost economic value. Without domestic processing capabilities, Indonesia remains dependent on imported materials for semiconductor manufacturing. The absence of advanced processing technologies, such as Fluidised Bed Reactor (FBR) for quartz purification and ion-exchange technology for gallium extraction, further hinders the development of a self-sufficient semiconductor supply chain (see Annex E). Government plans to develop silica smelters to at least produce ingot silicon have not yet materialised, limiting Indonesia's ability to establish a self-sufficient semiconductor supply chain.

2. **Challenges in aligning industrial zones with semiconductor industry needs**
   Indonesia has developed industrial zones and special economic zones to support high-tech industries, including semiconductors, but aligning these areas with the specific needs of the semiconductor industry remains a challenge. Unlike Penang, Malaysia, where semiconductor companies developed first and then industrial clusters followed, Indonesia has established electronic manufacturing zones without a strong semiconductor presence. While some progress has been made, several industrial areas still face infrastructure limitations, including stable electricity, high-quality water supply, and an efficient logistics network. These factors have made it more challenging to attract semiconductor investments and fully integrate the industry into existing industrial zones.

3. **Inadequate industrial support systems for semiconductor manufacturing**
   The semiconductor industry requires reliable electricity, water, and waste management facilities to operate efficiently. However, as noted in an interview with an industry stakeholder, Indonesia's electricity costs are relatively high, and clean water supply is inadequate in key industrial zones. Furthermore, existing waste management systems do not yet meet the stringent environmental requirements for semiconductor manufacturing, making large-scale production difficult to sustain. Large semiconductor manufacturers require at least 500-800 MW of power, which exceeds the current capacity of many industrial parks, such as Batam. Without significant upgrades, Indonesia may struggle to attract high-end semiconductor fabrication facilities.

4. **Absence of a centralised semiconductor research and development hub**
While some research facilities exist, such as ITB's infrastructure, many remain incomplete or underutilised. Government funding has provided equipment for semiconductor research, but operational funding remains a challenge. Unlike Taiwan and South Korea, Indonesia lacks a national semiconductor R&D centre that coordinates innovation efforts, further limiting its ability to compete in advanced semiconductor technology.

5. **The development of environmentally sustainable semiconductor manufacturing infrastructure also remains a challenge**
An industry representative mentioned in an interview that the semiconductor sector requires significant energy and water resources, but Indonesia's renewable energy adoption in industrial zones remains low. Without policies promoting green manufacturing and resource-efficient production, Indonesia may struggle to meet international environmental standards for semiconductor fabrication. Expanding access to clean energy and improving environmental sustainability measures will be critical in attracting international semiconductor investors.

Challenges in Research & Development and Commercialisation

The growth in Indonesia's semiconductor industry is hindered by challenges in R&D and commercialisation. While semiconductor technology has the potential to drive innovation in various sectors, progress is limited by the lack of domestic manufacturing infrastructure, weak research collaboration frameworks, and complex regulatory processes.

1. **Dependence on foreign licensing**
The absence of domestic semiconductor intellectual property (IP) firms forces Indonesian researchers to license innovations from foreign companies, restricting national control over locally developed technologies and limiting value capture. Intellectual property is a driver of competitiveness in the semiconductor industry, yet Indonesia lacks the legal and institutional support to protect and monetise local innovations. Indonesia's weak IP ecosystem leads to lost opportunities, as illustrated by the case of Indonesian professors who developed three-dimensional camera chip technologies, only for their intellectual property rights to be acquired by Apple and integrated into the iPhone 13. This case highlights the barriers Indonesian innovators face in securing IP rights, which not only restricts national industrial growth but also places Indonesia in a paradoxical position of paying licensing fees for technologies originally conceived by its researchers.

2. **Limited financial support for R&D**
Indonesia's semiconductor ecosystem faces constraints in financial support for research and development, particularly in lithography technology, high software licensing costs, and insufficient tax incentives. High chip design software costs, reaching USD 1–2 million annually, pose a financial barrier for emerging research ecosystems. Software expenses constitute the largest cost in chip design, especially for complex semiconductor structures [81]. While the US and China provide direct financial support, Indonesia relies on tax incentives, such as a 300% gross income deduction for R&D, which remains inadequate.

3. **Lack of structured research collaboration framework**
   The absence of a structured research collaboration framework weakens Indonesia's semiconductor R&D ecosystem, limiting effective partnerships between academia, government, and industry. Indonesia faces legal, financial, and administrative barriers that slow research initiatives. Bureaucratic hurdles delay funding and approvals, making it difficult to align research efforts with industry needs. The lack of a formalised technology transfer mechanism further restricts knowledge exchange and the adoption of advanced expertise. Strengthening collaboration through a structured framework is essential to drive innovation and accelerate the development of Indonesia's semiconductor industry.

4. **Weak semiconductor innovation ecosystem**
   The underdeveloped innovation ecosystem in Indonesia's semiconductor industry has hindered the emergence of startups, particularly in semiconductor design. Limited access to research funding, weak collaboration between academia and industry, and the absence of structured support for early-stage companies have stifled the growth of design houses. Without a strong foundation for innovation, Indonesia struggles to build a competitive semiconductor ecosystem capable of fostering technological advancements and attracting investment. If left unaddressed, this weakness will continue to limit the country's ability to establish a sustainable and self-sufficient semiconductor industry.

5. **Barriers to commercialising locally designed semiconductors**
   The lack of domestic semiconductor fabrication and testing facilities in Indonesia severely limits the commercialisation of locally designed ICs and prototypes. Dependence on overseas facilities increases production costs and delays market entry, placing local innovations at a competitive disadvantage. Despite having the expertise to design advanced ICs, Indonesian designers and researchers must send their prototypes abroad for fabrication and testing, adding financial and logistical challenges. While collaborations with institutions like NEXTLAB in photonics-based IC development and Kalbe Farma in biosensor innovation demonstrate Indonesia's technical potential, the absence of an integrated local ecosystem for fabrication, testing, and market scaling prevents the country from fully capitalising on its semiconductor innovations.

Box F. Workforce Needs in Indonesia's Semiconductor Ecosystem

Indonesia faces a shortage of skilled professionals across all stages of the semiconductor industry, design, fabrication, and ATP, which hinders its ability to compete globally. This talent gap is driven by several structural challenges, including limited access to specialised facilities and advanced technologies, insufficient hands-on training opportunities, and weak collaboration between academia and industry. In chip design, local firms often rely on foreign expertise due to the scarcity of professionals trained in microelectronics, IC design, and computer-aided design (CAD). In fabrication, the absence of large-scale wafer manufacturing facilities hampers the development of practical skills and the growth of front-end semiconductor clusters. While Indonesia shows greater potential in ATP, workforce training in this segment remains less developed than in regional peers such as Malaysia and Vietnam. Recognising these gaps, the Ministry of Manpower has outlined workforce requirements and development strategies across the semiconductor value chain, emphasising the need for targeted training and collaboration with global stakeholders (see Table 4.1).

TABLE 4.1. Indonesia's Workforce Requirements and Development Strategy in Semiconductor Ecosystem

No.	Phase	Objective	Required Workforce Types	Human Resource Development Strategy
1.	Research and Development (R&D)	To develop innovative chip technology and architecture	• Semiconductor Material Researchers (PhD/Master in Material Science, Chemistry, Physics) • Electronics & Microelectronics Engineers • AI & Machine Learning Specialists for Chips • Lithography & Nano Manufacturing Experts	• Graduate and doctoral scholarships • Research collaboration with universities and global industries • Internships at international semiconductor research institutions
2.	Engineering (Design & Innovation)	To design chips according to industrial needs	• IC Design Engineers (ASIC, FPGA, RTL) • Verification & Testing Engineers • Software & Embedded System Engineers • Signal Processing & Power Electronics Experts	• Establishment of a national chip design centre • IC design training based on Cadence, Synopsys • Collaboration with global chip design companies
3.	Fabrication/ Manufacturing	To produce chips on an industrial scale	• Process Engineers (Lithography, Etching, Doping) • Yield Engineers & Metrology Engineers • Fab Operators & Maintenance Engineers • Packaging & Testing Specialists	• Specialised semiconductor polytechnics and vocational schools • Technology transfer from global foundries • Vocational training in chip manufacturing industries
4.	Business & Industrial Ecosystem	To develop market and industrial strategy	• Semiconductor Supply Chain Experts • Market & Technology Policy Analysts • Product Management & Business Development Experts • Technology Law & Regulation Specialists	• Technology-based MBA programmes • Supply chain & industry policy training • Partnerships with global semiconductor companies

Source: Ministry of Manpower (2025)

4.3. SWOT Analysis of Indonesia's Semiconductor Ecosystem

Indonesia's semiconductor industry holds notable potential, supported by a large and growing workforce, increasing government attention, and abundant natural resources that could contribute to semiconductor manufacturing. However, progress remains hindered by limited domestic production capacity, fragmented R&D efforts, and inadequate infrastructure. At the same time, Indonesia's strategic geographic location, ongoing digital transformation, and attractiveness for foreign direct investment present opportunities for growth. Despite these prospects, the industry faces considerable threats, including geopolitical uncertainties, intense global competition, and rapid technological advancements.

The SWOT analysis of Indonesia's semiconductor ecosystem was derived from a consultative workshop (see Annex D). During the discussions, participants not only identified but also prioritised the most critical strengths, weaknesses, opportunities, and threats shaping the sector. While previous chapters have outlined various advantages and challenges, this section focuses on the key SWOT factors that stakeholders deemed most crucial for the industry's development.

FIGURE 4.3. **The SWOT Analysis on Semiconductor Ecosystem in Indonesia**

Source: Consultative Workshop conducted by LPEM FEB UI (2025)

Strength: Strong Government Support with Abundant Resources

Indonesia possesses several strengths that can support the development of its semiconductor industry. These advantages provide a strong foundation for growth and enhance the country's potential to integrate into the global supply chain.

1. **Growing government support**
   The government recognises the semiconductor industry's potential as a driver of economic and technological advancement. While specific policies and incentives are still in development, efforts are underway to explore strategies that can foster industry growth and attract investment.

2. **Demographic dividend**
   A large and growing workforce presents an opportunity to develop a strong talent pool for the semiconductor sector. With targeted education and training, Indonesia can build the necessary skills to support industry expansion.

3. **Abundant natural resources**
   The availability of key raw materials, such as nickel and other critical minerals, strengthens Indonesia's position in the semiconductor supply chain. Developing upstream industries can reduce dependence on imports and enhance domestic capabilities.

Weakness: Underdeveloped Semiconductor Ecosystem

The Indonesian semiconductor ecosystem exhibits several weaknesses in terms of infrastructure, education, business, and regulatory support. This weakness has the potential to become a barrier for Indonesian semiconductor environment if the government and other experts don't take a serious action.

1. **Deficiency on the availability and quality of infrastructure**
   There is a deficiency in both the quantity and quality of infrastructure supporting the semiconductor sector in Indonesia. Experts from both the industry and government have highlighted the urgency of improving semiconductor infrastructure, particularly if Indonesia aims to develop the fabrication chain, which requires significant amounts of pure water and electricity to support operations. Furthermore, educational experts have also identified limitations in semiconductor infrastructure, as vocational high schools currently lack access to semiconductor equipment and facilities. Since vocational graduates are expected to serve as operators in the ATP process, deficiencies in educational experience will negatively affect the graduates' competencies.

2. **Limitations in curriculum support**
   The curricula in both higher education and vocational training have yet to fully integrate semiconductor-related content. Only a handful of institutions offer semiconductor learning within engineering programmes, and even then, the coverage remains limited. These programmes fall short of the depth and breadth found in dedicated semiconductor curricula (see Chapter 1.2).

3. **Lack of business leadership**
   The development of Indonesia's semiconductor ecosystem raises an important question about where the initiative should originate, whether from the government or the private sector. Without strong government intervention, businesses may struggle to take the lead in establishing a domestic semiconductor industry. The high initial costs, long investment horizons, and complex technological requirements make it unlikely that business leaders will

independently drive the industry’s growth. While private sector involvement remains crucial, the government’s role in creating an enabling environment is seen as essential, particularly in the early stages, to attract investment and support industry development.

4. **Inconsistencies in government regulations**
   Inconsistencies in government regulations could directly impact Indonesia's position in the semiconductor. The government needs to provide consistent regulatory support across all sectors, including industry, materials, and education, to ensure the successful implementation of Indonesia's long-term semiconductor industry roadmap.

5. **Lack of customs officers’ information of good and product classification**
   Experts agreed that some customs officers lack comprehensive knowledge of product classification, particularly for semiconductor-related items. This lack of expertise can lead to misclassification, causing semiconductor components to be categorised incorrectly as non-semiconductors. As a result, these products may miss out on government incentives. Therefore, improving the competency of personnel is essential to ensure accurate identification of semiconductor products and components.

6. **Fragmented semiconductor ecosystem**
   Indonesia’s semiconductor-related activities operate in isolation rather than as an integrated ecosystem. The material extraction and processing sector focuses primarily on exports, with limited downstream integration. Design professionals often seek opportunities abroad due to the lack of domestic capacity to support advanced semiconductor design. Similarly, the ATP segment functions independently, with limited activity on fostering local industry development. This also highlights the role of the Semiconductor Task Force in coordinating and orchestrating all stakeholders to enable the development of a domestic semiconductor ecosystem in Indonesia.

Opportunity: Emerging Digital Opportunities and Geopolitical Advantages

Despite Indonesia’s internal strength and weakness, external factors also play an equally significant role to support domestic semiconductor ecosystem. There are several circumstances which could drive the semiconductor ecosystem, further opening the window of opportunity for Indonesia.

1. **The growth of digital lifestyle**
   The vast establishment of digital ecosystem represents as one of the opportunities of Indonesia’s semiconductor ecosystem. The shifting in lifestyle, specifically since the COVID-19 pandemic, has further pushed the usage of technology. Digital lifestyle, a new way of living which utilise digital technology for various endeavours, has notably gained popularity around the globe, including Indonesia. As digital technologies rely on semiconductors as essential components, their sustained demand is expected to drive the increasing need for semiconductors, thereby opening the window of opportunities.

2. **Technological disruptions**
   Technology has long been considered as a disruptive force, impacting at any level of scales, from an individual to a country. Continuous advancement of technology would have a wide range of impacts on products and services, thus potentially transform the systematic civilisations. The dependence on technology in daily live will only generate more demand, stimulating the growth of semiconductor ecosystem.

3. **Indonesia's neutral position for investment**
In addition, Indonesia's neutral political position creates opportunity for semiconductor-related investment from other countries. Without a strong attachment to a certain major bloc, Indonesia remains open for partnership with various countries. This neutrality allows Indonesia to attract investments from key industry players, such as TSMC in Taiwan or X-FAB in Germany, without facing political complications related to its position within a specific bloc.

4. **New investment policy alternative**
Under the new presidential administration, Indonesia has introduced an alternative investment policy to stimulate domestic investment. This policy aims to expand and optimise Indonesia's asset and wealth as a development instrument to drive economic growth. Through effective asset management, Indonesia aims to invest in several key projects according to development priorities, with job creation and expected public income as consideration. Additionally, this policy provides an opportunity for Indonesia to invest in various sectors independently, including semiconductors, without relying on foreign investment.

5. **Chip-war**
The chip war signifies intense competition for dominance in the semiconductor industry, which is classified as crucial for technological advancement. However, semiconductor ecosystem, which only constitutes of a few global major players, is heavily clouded with geopolitical aspects. The semiconductor ecosystem's reliance on and susceptibility to geopolitical dynamics may create opportunities for new, neutral entrants to emerge.

Threat: Low Investor Appeal and Geopolitical Competition

Several factors threaten the development of Indonesia's semiconductor industry, limiting its ability to grow and compete with more established players in the region. These challenges could prevent Indonesia from fully capitalising on the industry's potential and integrating into the global supply chain.

1. **Lack of industry cluster to attract investment**
Indonesia struggles to attract semiconductor investors due to the absence of a well-developed industry cluster. Unlike neighbouring countries that have established strong networks of semiconductor firms, research institutions, and supply chain partners, Indonesia has yet to build the critical mass necessary for a thriving semiconductor hub. Without an integrated ecosystem that provides reliable infrastructure, skilled talent, and industry collaboration, Indonesia faces difficulties in securing investment and competing in the global semiconductor market.

2. **Minimal local workforce involvement**
Many advanced roles, including research, chip design, and fabrication, continue to be dominated by foreign expertise due to a shortage of locally trained specialists. This reliance on external talent restricts knowledge transfer and slows the development of domestic capabilities in the industry.

3. **Intensifying global technological competition**
   The semiconductor industry is highly competitive, with leading economies investing heavily in research, development, and innovation. Other countries continue to strengthen their positions through substantial capital investment and a range of incentives designed to attract businesses and talent. Indonesia faces challenges in keeping pace, as it lacks comparable levels of financial support and policy incentives to foster industry growth.

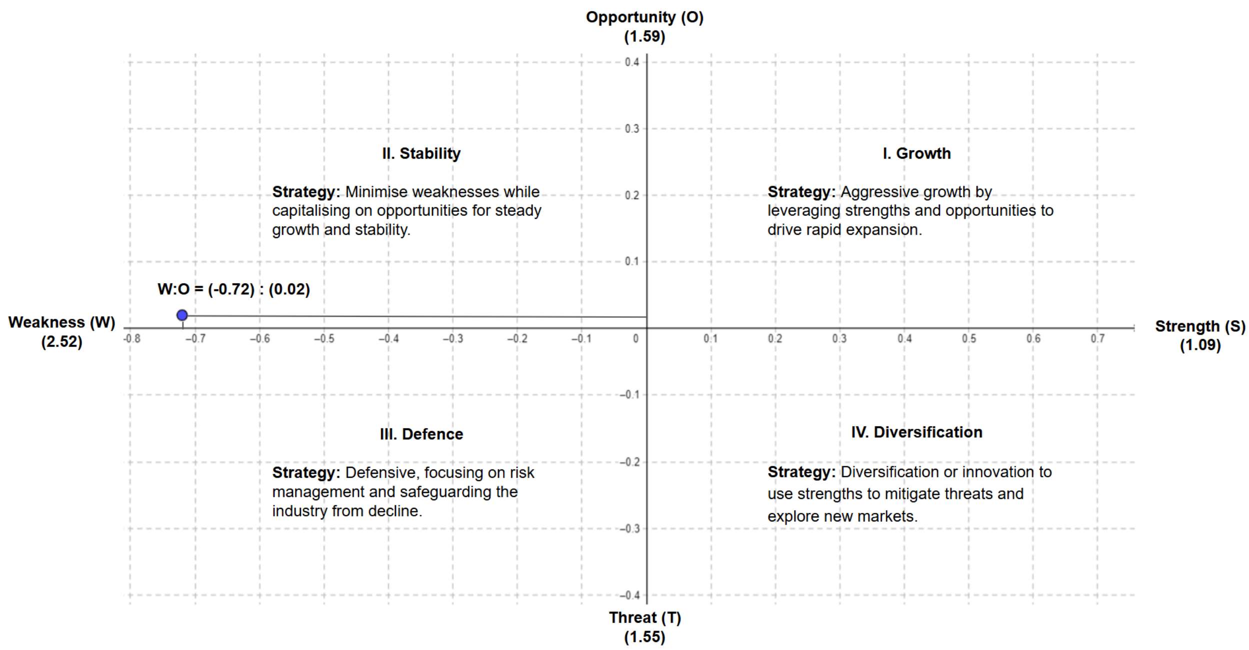
4. **Policy uncertainty and political commitment**
   While there is recognition of the semiconductor industry's potential, the absence of a clear and consistent policy framework raises concerns about long-term commitment. Political uncertainties and the lack of concrete initiatives hinder efforts to build a competitive and sustainable semiconductor sector.

The SWOT Analysis

The SWOT analysis of Indonesia's semiconductor industry reveals a strategic landscape where internal strengths like government support are counterbalanced by weaknesses such as policy uncertainty. Externally, the industry faces urgent threats from global technology competition, while also benefiting from opportunities like abundant natural resources. A key feature of the analysis is its emphasis on urgency: factors such as political commitment and policy uncertainty demand immediate resolution, whereas others like natural resource availability, though important, are less time-sensitive.

Using IFAS (Internal Factor Analysis Summary) and EFAS (External Factor Analysis Summary) matrices, the industry is positioned in the Stability (WO) quadrant, indicating that while weaknesses exist, they can be mitigated by leveraging opportunities. The detailed methodology for calculating these scores is provided in Annex G. This strategic positioning, visualised in the SWOT Cartesian Diagram (Figure 4.4), guides policymakers to prioritise urgent issues and capitalise on strengths for sustainable growth. Matrix result of analysis on strategy combinations is listed in Annex G.

FIGURE 4.4. SWOT Cartesian Diagram



Source: LPEM FEB UI (2025)

CHAPTER 5

Recommendations for Indonesia’s Semiconductor Ecosystem: Building a Roadmap for Growth

This chapter outlines key recommendations developed by WO Strategy to support Indonesia’s semiconductor industry growth, focusing on strategic priorities, policy directions, and international collaborations. To provide a structured approach to recommendations for Indonesia’s semiconductor industry development, this chapter is organised as follows:

- **Chapter 5.1 defines the country’s long-term aspirations and strategic direction for semiconductor development.** To operationalise this vision, a strategic roadmap is presented, detailing short-term, medium-term, and long-term strategies aimed at strengthening domestic capabilities, fostering innovation, and attracting investment. These steps are crucial to addressing industry gaps, ensuring regulatory improvements, and enhancing Indonesia’s integration into the global semiconductor supply chain.
- **Chapter 5.2 explores potential areas for international collaboration, particularly with the UK.** This section identifies key opportunities for policy support, technology transfer, investment facilitation, and industry partnerships that could accelerate Indonesia’s semiconductor development.

5.1. Indonesia’s Semiconductor Vision and Roadmap

With a vision of becoming a key player in the global semiconductor ecosystem by leveraging its resource advantages, Indonesia is suggested to adopt a strategic approach to industry development. Given the country’s current capabilities, design and ATP offer the most viable entry points for rapid integration into the global semiconductor value chain. While fabrication and materials processing remain long-term goals, establishing a strong foundation in design and ATP will be essential for building industry expertise, attracting investment, and fostering innovation.

Indonesia's semiconductor industry is at a pivotal stage, presenting both opportunities and challenges in its development. A clear, long-term vision is essential to harness the country’s natural resource advantages while systematically building its technological and industrial capabilities. To guide this transformation, Indonesia needs to adopt a clear national vision:

"Becoming a key player in the global semiconductor ecosystem by leveraging Indonesia’s resource advantages."

This vision ensures that the country's semiconductor development remains rooted in the effective utilisation of both its natural and human resources, aligning its industrial strategy with long-term economic and technological growth objectives. However, Indonesia's ambition to develop a competitive semiconductor industry faces several structural challenges across policy, talent, infrastructure, research, and innovation ecosystems. Addressing these barriers is essential to unlocking the sector's potential and positioning Indonesia within global semiconductor value chains. The following section outlines key challenges and corresponding policy recommendations to support the development of a robust and integrated semiconductor ecosystem. A proposed roadmap will follow to provide a phased implementation strategy.

TABLE 5.1. Challenges and Recommendation to Indonesia's Semiconductor Development

NO	Key Challenge	Challenge	Recommendation
1	Policy and regulatory framework	1. No unified national semiconductor strategy and progress remains fragmented 2. Underdeveloped FDI and tax incentive frameworks reduce competitiveness 3. Inefficient import-export procedures and customs delays hinder supply chain flow 4. Limited technical expertise and lack of structured knowledge transfer mechanisms 5. Weak intellectual property protections deter foreign collaboration	1. Develop a unified national semiconductor strategy coordinated across ministries. 2. Clarify investment and FDI regulations to boost investor confidence. 3. Enhance incentives (e.g. tax holidays) and streamline permitting. 4. Equip targeted SEZs (e.g. KEK Nongsa, KEK Tanjung Sauh) with required utilities and logistics for semiconductor needs.
2	Human capital and talent development	1. Shortage of skilled talent due to low engineer-to-population ratio and limited hands-on training 2. High costs of educational infrastructure and software 3. Brain drain driven by better overseas and cross-sector opportunities	1. Establish national competency standards tailored to semiconductor industry needs. 2. Reform vocational and university curricula to increase practical, industry-aligned content. 3. Promote public-private partnerships for training and access to subsidised tools and facilities. 4. Strengthen linkages between education and industry to improve employability and retention.
3	Infrastructure	1. Abundance of raw materials, but lack of technology for high-purity processing 2. Industrial zones often lack stable electricity, clean water, and waste systems 3. High utility costs and absence of centralised R&D hubs 4. Low adoption of renewable energy limits sustainable manufacturing prospects	1. Create R&D hubs connecting universities, startups, and industry. 2. Provide public support (grants/co-financing) for prototyping and IP commercialisation. 3. Lower barriers such as software and fabrication access costs to stimulate innovation.

To translate these recommendations into actionable steps, a structured roadmap is essential (detailed in Annex H). The roadmap below outlines short-, medium-, and long-term priorities to guide Indonesia's semiconductor development, ensuring policy coherence, coordinated investment, and sustained momentum across supply chain.

1. **Short-term (2-3 years)**

   Indonesia's semiconductor strategy should prioritise upstream development in materials, particularly by promoting investment in photovoltaic and electronic-grade silicon wafer production, supported by improved infrastructure and enhanced customs capacity to ensure supply chain resilience. In the design segment, the focus lies in establishing both fiscal and non-fiscal incentive frameworks to strengthen existing design houses, attract new investment, and foster human capital through scholarships, internships, and international collaborations, while also exploring shared access to design tools. For fabrication, initial steps will involve comprehensive feasibility and engineering studies, alongside the cultivation of global partnerships to secure access to technology, equipment, and capital. In assembly, testing, and packaging, efforts will concentrate on expanding capacity through investment mobilisation, workforce development, and collaboration with high-tech firms to support knowledge transfer and build a competitive ecosystem.

2. **Medium-term (4-5 years)**

   Indonesia is encouraged to advance value-added production in semiconductor materials through targeted foreign investment in silica smelters, gallium nitride, and polysilicon, while promoting research and development as well as technology transfer to strengthen domestic capabilities. In design, the medium-term strategy should focus on expanding chip design activities, establishing licensing frameworks, and collaborating with global design firms, alongside the development of competency standards to safeguard intellectual property and build market credibility. For fabrication, pilot-scale wafer production should be initiated for selected applications, supported by institutional mechanisms that facilitate technology transfer and capacity-building among local firms. In assembly, testing, and packaging, continued expansion should be accompanied by measures to stimulate domestic demand, attract capital, and implement coordinated market development to ensure long-term competitiveness.

3. **Long-term (6-10 years)**

   Indonesia is advised to position itself as a global supplier of semiconductor materials by expanding advanced production facilities, supported by a strengthened research and development ecosystem to foster innovation and reduce reliance on external sources. In design, long-term efforts should aim to develop Indonesia as a regional hub for chip design talent, underpinned by robust licensing and intellectual property frameworks to enable domestic production of licensed integrated circuits and enhance industry sustainability. For fabrication, the country is encouraged to pursue commercial-scale production of secure modules and microcontrollers,

with a gradual transition to more advanced components, requiring sustained investment, regulatory facilitation, and continuous technological upgrading. In assembly, testing, and packaging, the focus should be on establishing a self-reliant and competitive ecosystem that ensures resilience, high-quality standards, and a skilled workforce to support Indonesia's integration into global value chains.

The Roadmap for Strengthening Indonesia's Semiconductor Ecosystem is organised across short-, medium-, and long-term timeframes, and is categorised into critical phases including materials design, fabrication, and ATP, as illustrated in Figure 5.1. The stakeholders involved in the development of the semiconductor industry are listed in Annex I.

FIGURE 5.1. Roadmap for Indonesia's Semiconductor Industry

	SHORT TERM 2 - 3 Years	MEDIUM TERM 4 - 5 Years	LONG TERM 6 - 10 Years
Materials	1. Expansion of Photovoltaic (solar Grade) Silicon Wafer Production through domestic and foreign investment 2. Expansion of Electronic Grade Silicon Wafer Production through domestic and foreign investment	1. Strengthening the downstream processing of semiconductor raw materials through foreign investment: a. Investment on Smelter Silica Electronic Grade, Gallium Nitride b. Investment on Polysilicon Electronic Grade, Gallium Nitride Industry 2. Facilitating technology transfer through collaboration with local partners in material processing 3. Initiating research and development in material processing	1. Strengthening the downstream processing of semiconductor raw materials through foreign and domestic investment: a. Investment on Smelter Silica Electronic Grade, Gallium Nitride b. Investment on Polysilicon Electronic Grade, Gallium Nitride Industry 2. Advancing research and development in material processing
Design	1. Incentives to strengthen existing design houses and establish new ones 2. Human Resource Development (incl. scholarship and internship) 3. Collaboration with international universities 4. Provision of collaborative design tools	1. Human Resource Development (incl. scholarship and internship) 2. IC Design Production collaborating with leading semiconductor company 3. Development of licensed IC chip production capabilities 4. Establishment of competency standards for IC design	1. Becoming a semiconductor talent centre to support a competitive design industry 2. Capability to produce licensed IC chips
Fabrication	1. Developing Detailed Engineering Design and conduct feasibility study 2. Finding global partner: a. Technology provider b. Equipment provider c. Investment	1. Technological transfer 2. Pilot-scale production of wafer fabrication for domestic industry (secure module, sensor, audio, microcontrollers chip more than 28 nanometres)	1. Small-scale factory commercialisation of wafer fabrication for domestic industry (secure module, sensor, audio, microcontrollers chip more than 28 nanometres) 2. Production and transfer technology in wafer fabrication (microprocessor, graphic processor, memory)
Assembly, Testing, and Packaging (ATP)	1. Encouraging new investment in ATP or expansion 2. Local partnership policies in the high-tech industry 3. Facilitating the improvement of local human resources quality (inc. vocation, training, teaching factory)	1. Strengthening investment in ATP or expansion 2. Stimulating market expansion to absorb locally produced semiconductors	1. Semiconductor industry ATP independence

Source: LPEM FEB UI (2025)

5.2. UK – Indonesia Collaboration Opportunities in Semiconductor Development

There are strong opportunities for collaboration between the UK and Indonesia to strengthen Indonesia's semiconductor ecosystem by leveraging each country's respective strengths. A key area for joint efforts is skills development, including the establishment of collaborative research programmes between universities, industry internships with UK semiconductor firms, and access to advanced education and training in the UK. Given the UK's expertise in chip design and semiconductor materials, there is potential to scale up related activities into the Southeast Asian market, including Indonesia. Although the UK has limited large-scale fabrication capacity, it possesses advanced fabrication technologies that could be explored through collaborative investment and knowledge-sharing initiatives in Indonesia.

TABLE 5.2. Opportunities for the UK to Indonesia's Semiconductor

NO.	Identified Gap in Indonesia	Potential Areas for UK-Indonesia Collaboration	UK's Relevant Strengths
1.	Policy and regulatory challenges 1. Absence of a clear national strategy 2. Uncertainty in investment regulations 3. Weak investment incentives 4. Ambiguous investment screening policies 5. Import and export regulations 6. Lack of structured knowledge transfer mechanisms	1. Share best practices in regulatory clarity and investment frameworks. 2. Support the design and institutionalisation of a national semiconductor strategy. 3. Offer policy advisory and training programmes on investment screening and regulation. 4. Partner in building a long-term roadmap aligned with Indonesia's entry-point strategy.	1. The UK is actively fostering early-stage chip design companies through various initiatives and programmes and is also working to formulate benchmarking frameworks within the semiconductor industry. 2. The UK experience in launching the National Semiconductor Strategy 2023 can also become a reference on how to design and institutionalise an effective roadmap. 3. The UK can become an important partner for Indonesia in its early phase of semiconductor expansion, including in the development of the long-term plan. In addition, the UK's focus on chip design in its long-term strategy provides similarity with Indonesia's entry point strategy.
2.	Human capital challenges 1. Shortage of skilled semiconductor professionals 2. Weak alignment between university curricula and industry needs 3. Challenges in semiconductor-focused education and training 4. Talent retention and brain drain	1. Launch talent development initiatives, such as facilitating on-the-job training opportunities for Indonesian workers in UK-based semiconductor companies. 2. Provide scholarships and funding schemes to enable Indonesian students to pursue advanced studies in the UK and promote student exchange programmes, particularly in semiconductor-related fields.	1. The UK has a well-established semiconductor industry ecosystem with leading global companies (e.g. Arm, Imagination Technologies). Practical experience in the UK enables the transfer of semiconductor knowledge and skills. 2. The UK offers world-class education in semiconductor-related fields. Indonesian students can gain a comprehensive understanding of semiconductors.

NO.	Identified Gap in Indonesia	Potential Areas for UK-Indonesia Collaboration	UK's Relevant Strengths
3.	Infrastructure challenges 1. Limited domestic processing of raw materials 2. Challenges in aligning industrial zones with the semiconductor industry's needs 3. Inadequate industrial support systems 4. Absence of a centralised semiconductor R&D hub 5. Development of environmentally sustainable infrastructure	1. Support development of IC design and Assembly, Testing, and Packaging (ATP) capabilities and promote the establishment of wafer fabrication facilities in Indonesia. 2. Facilitate strategic partnerships to boost industrial ecosystem readiness.	1. The UK retains globally benchmarked expertise in chip design and IP, R&D, and compound semiconductors and capitalises on the UK's strengths in the global supply chain by generating strategic partnerships with peer countries [82].
4.	Research & development and commercialisation challenges 1. Dependence on foreign licensing 2. Limited financial support for R&D 3. Lack of a structured research collaboration framework 4. Weak semiconductor innovation ecosystem 5. Barriers to commercialising locally designed semiconductors	1. Provide matching grants and funding for prototype development and IP commercialisation. 2. Establish collaborative research initiatives between the UK and Indonesian universities. 3. Provide research funding and grants to support collaborative research in semiconductor-related fields.	1. ChipStart provides early-stage companies with access to commercial design capabilities, expertise, mentorship, and exposure to private capital. The programme has helped startups secure funding and form key partnerships, accelerating the commercialisation of their technologies [83]. 2. The UK government has invested up to GBP 1 billion to bolster its semiconductor industry, focusing on research and development (R&D), design, and compound semiconductors [84]. 3. The UK universities have strong research capabilities in semiconductor-related fields. Joint research collaborations can facilitate knowledge transfer, foster innovation, and establish a solid foundation for semiconductor R&D in Indonesia.

Source: LPEM FEB UI (2025)

These are several specific areas of strategic collaboration between Indonesia and the UK in developing Indonesia's semiconductor ecosystem:

1. **The UK and Indonesia can jointly strengthen policy and regulatory frameworks to accelerate the development of Indonesia's semiconductor ecosystem, drawing on the UK's experience in formulating a national semiconductor strategy and its leadership in creating transparent, innovation-friendly industrial regulations.** Collaboration may include shaping a long-term semiconductor roadmap, streamlining investment procedures, enhancing FDI screening mechanisms, and improving customs and trade facilitation processes. Through mutual dialogue, the UK can offer strategic lessons on maintaining regulatory clarity while fostering a dynamic business environment, aligning with Indonesia's aspiration

for a cohesive and competitive national strategy. For the UK, this collaboration reinforces its thought leadership in global semiconductor governance, expands its influence in shaping emerging market regulatory models, and strengthens its strategic presence in Southeast Asia, a region critical to global supply chain resilience.

2. **Building Indonesia's chip design talent and technical workforce is central to long-term ecosystem growth and the UK is well positioned to support this through its globally recognised universities, strong vocational systems, and industrial training programmes within leading semiconductor firms.** Joint efforts may include curriculum development, particularly in semiconductor-related fields such as Compound Semiconductor Electronics programme at Cardiff University, academic exchanges, scholarships, and practical placements. On-the-job training for Indonesian workers at UK-based companies, such as Arm, Pragmatic Semiconductor, and Dialog Semiconductor, would equip participants with industry-relevant skills and close the talent gap. Additionally, higher education partnerships can be deepened through exchange and scholarship schemes with UK universities offering specialised programmes in compound semiconductors and microelectronics, including those at Cardiff, Bristol, and Swansea. For the UK, such initiatives expand the global reach of its universities and companies, attract potential international students and trainees, and foster long-term institutional partnerships. It also expands the international footprint of its firms and universities, enhance their relevance in Southeast Asia's innovation landscape, and strengthen the UK's position as a global leader in semiconductor education, talent development, and commercial engagement.

3. **Developing Indonesia's semiconductor design ecosystem should be a key priority for bilateral research and innovation collaboration, particularly as the UK offers advanced capabilities in chip design, compound semiconductors, IP commercialisation, and public–private research funding mechanisms.** Joint programmes may include co-funded research grants, prototype development initiatives, and shared access to design tools. Existing UK initiatives, such as ChipStart, which provides early-stage companies with access to commercial design capabilities, expertise, mentorship, and exposure to private capital, could be adapted to Indonesia's needs, helping accelerate local innovation while fostering technology transfer. Collaborative research projects between UK and Indonesian institutions can also leverage frameworks, such as the Newton Fund, the Global Challenges Research Fund, and Innovate UK, particularly in the area of chip design and compound semiconductors to forge a strong chip design research ecosystem which have been initiated by several domestic institutions (e.g., ITB, UI, and ICDEC). This research collaboration may also involve several leading universities in the UK (e.g., University of Oxford, University of Cambridge, and Imperial College. For the UK, such collaboration strengthens its global leadership in chip design and compound semiconductors, provides UK-based firms and research institutions with access to emerging markets and pilot frontier technologies, and enhances the international relevance and impact of its funded research programmes by aligning with Indonesia's fast-growing innovation ecosystem.

4. **Infrastructure cooperation represents another promising area, particularly in the context of Indonesia's Special Economic Zones (SEZs), where the UK's expertise in sustainable industrial development, clean energy planning, and infrastructure investment can support fabrication and ATP expansion aligned with global standards.** The UK could assist in designing zones that meet the stringent infrastructure requirements for semiconductor production, ensuring clean water, stable electricity, and responsible waste management. Beyond advisory roles, the UK may contribute to wafer fabrication development through direct and portfolio investments. For the UK, such collaboration aligns with its ambition to enhance its global role in chip manufacturing, while Indonesia offers competitive advantages in workforce availability, resource access, and proximity to major markets.

5. **As Indonesia's semiconductor ecosystem matures, it is equally important to establish a secure and internationally aligned enabling environment, and the UK's strengths in cybersecurity, data governance, and regulatory frameworks provide a solid foundation for joint efforts to enhance trust, interoperability, and innovation.** Bilateral initiatives may include developing transparent legal frameworks for IP protection, cross-border data governance, and critical infrastructure security. These efforts would improve investor confidence and facilitate smoother global integration. Strengthening university–industry linkages, particularly in cybersecurity training, research commercialisation, and digital ethics, will also be key to embedding long-term resilience in Indonesia's innovation ecosystem. For the UK, such engagement creates opportunities to internationalise its digital standards and co-develop trusted digital infrastructure, thereby strengthening its position as a global leader in secure technology governance.

These areas of collaboration represent a broader opportunity to forge a long-term strategic partnership between Indonesia and the UK in the semiconductor sector. These collaborations will strengthen the UK's leadership in global semiconductor governance and value chain, particularly in chip design and compound semiconductors, where this collaboration may expand its economic and geopolitical positioning in the Southeast Asia's region. This collaboration may also expand the international reach of the UK's universities and companies which may also strengthen the UK's domestic semiconductor ecosystems. Through joint efforts in investment, education, research, and workforce development, both countries can accelerate the growth of Indonesia's semiconductor industry while reinforcing their complementary roles in the global value chain.

CHAPTER 6

Seizing the Opportunity: Charting Indonesia's Path in the Global Semiconductor Industry

Indonesia stands at a pivotal juncture in its effort to strengthen its position in the global semiconductor value chain. The country holds significant strategic advantages, from abundant raw materials like tin, nickel, and silica sand, to its proximity to major semiconductor hubs in Asia. Coupled with a growing domestic market driven by demand in electronics, automotive, and digital services, these factors offer Indonesia a unique opportunity to develop a robust semiconductor industry.

However, turning this potential into long-term competitiveness will require addressing persistent structural challenges. These include limited R&D infrastructure, a shortage of specialised talent, fragmented policy coordination, and a continued reliance on imported semiconductor components. While promising initiatives such as the Semiconductor Ecosystem Task Force and ICDeC are important first steps, a more integrated and forward-looking approach is needed to build a comprehensive and self-sustaining ecosystem.

With sustained political commitment, targeted investment, and strong international cooperation, Indonesia can begin to move up the value chain, from assembly and packaging towards design and, eventually, fabrication. The path ahead is complex, but the foundations are in place. By leveraging its strengths and closing critical gaps, Indonesia can chart a future as a key regional player in the global semiconductor landscape.

Developing a clear, phased roadmap is essential to guide Indonesia's semiconductor ambitions. Over the next 2–3 years, efforts should concentrate on building chip design capabilities, investing in materials research, and undertaking feasibility assessments. In the medium term (4–5 years), the focus should shift towards scaling production, enabling effective technology transfer, and reforming institutional structures. Looking ahead to the long term (6–10 years), the priority will be to establish innovation-led capacity across the full value chain, including materials, design, fabrication, and ATP. With strong coordination among government, industry, and academia, and consistent engagement with international partners, Indonesia can position itself as a resilient, competitive, and credible hub for semiconductor innovation and manufacturing.

In addition, strategic collaboration with international partners, including the UK, will be essential to complement and reinforce national efforts. To further strengthen this partnership, Indonesia can collaborate with the UK on talent mobility schemes and R&I incubator hubs tailored to semiconductor start-ups, fostering an environment conducive to long-term innovation. Through these joint initiatives, both countries stand to benefit - Indonesia can accelerate its industrial development and enhance self-reliance, while the UK reinforces its strategic presence in Southeast Asia and cultivates new economic and academic linkages in a high-growth market.

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Annexes

Annex A

List of work packages and their corresponding report chapter:

Work Package	Research Questions
1: Landscaping	1. What are the key demand and supply side factors impacting Indonesia’s semiconductor industry?
	2. Who are the key stakeholders in Indonesia's semiconductor ecosystem, both domestic and international, and what roles do international partners and investors play?
	3. What are the current national and regional policies and regulations governing the semiconductor industry?
	4. How can Indonesia leverage its natural resources for raw materials and employ its geographical advantages to boost its semiconductor manufacturing capabilities?
	5. What are the main areas of application for semiconductors in Indonesia? What are the current levels of (a) research and development and (b) commercialisation in these areas?
	6. What is the production and market potential of Indonesia’s semiconductor industry, and how can it contribute to the country's overall economic growth and technological advancement?
	7. How does Indonesia’s semiconductor landscape compare with other countries such as ASEAN, China, and the US?
2: Foresight	1. What are the critical challenges that Indonesia needs to address to enhance its semiconductor industry, particularly in terms of policy and regulatory reforms, human capital, and infrastructure?
	2. What trends and opportunities for growth exist over the next 5-10 years in the Indonesian semiconductor industry? How do they compare with global trends?
	3. What strategic initiatives can Indonesia implement to strengthen its semiconductor industry and secure a competitive edge in the global market?
	4. What are the global best practices around policy and strategy that can inform Indonesia’s semiconductor industry? What lessons can Indonesia learn specifically from the UK’s semiconductor policy and strategies?
	5. How can the UK support Indonesia in advancing the semiconductor industry (through R&D partnerships, funding and technical assistance)? What could be the roles of the UK Government, academia and industry players in this regard?
3: Recommendations	1. (Based on WPs 1 and 2) What would be the key recommendations for the development of a robust semiconductor ecosystem in Indonesia over the next five to ten years?

Source: FCDO (2024) and LPEM FEB UI (2025)

Annex B

List of industry experts consulted for this study are available below:

No.	Stakeholder	Institution	Position	Name
1.	Industry Expert	Indonesian Semiconductor Industry Practitioners Association (PPISI)	Director	Ida Bagus Ngesti Dewa Manuaba
2.	Industry Expert	School of Electrical Engineering and Informatics ITB	Professor	Trio Adiono
3.	Industry Expert	IASI German	German IASI ETTB Division Coordinator	Sri Wahyuni Basuki

Annex C

List of participants that has been interviewed are available below:

No.	Stakeholder	Institution	Position	Name
1.	Government	The Coordinating Ministry for Economic Affairs:	Semiconductor Ecosystem Preparation Task Force	Edi Prio Pambudhi
2.	Government	The Indonesian National Research and Innovation Agency (BRIN)	Head of Research Organisation for Electronics and Informatics, Head of the Electronics Research Centre	Budi Prawara, Yusuf Nur Wijayanto
3.	Government	The Ministry of Manpower	Head of Centre for Workforce Planning	M. Mustafa Sarinanto
4.	Government	The Ministry of Industry	Directorate General of Metal, Machinery, Transportation Equipment, and Electronics Industries (ILMATE)	Ronggolawe Sahuri, Rizki Triana, Abdillah Einstein
5.	Industry Association	Electronic Entrepreneurs Association (GABEL)	Member of GABEL, General Manager Business Development PT Hartono Istana Teknologi (Polytron)	Joegianto
6.	Industry Association	Indonesian Telematics Device Industry Association (AIPTI)	Chairman of AIPTI, President Director at PT Panggung Electric Citrabuana	Ali Soebroto Oentaryo
7.	Industry Association	Indonesian Association of Information Technology Manufacturers (AiTI)	*(presented by a representative)*	*(presented by a representative)*
8.	Semiconductor Company	PT Infineon Technologies Batam	Director of Logistics	Aldrin Poernomo
9.	Semiconductor-related Stakeholder & Educational Institution	Indonesia Chip Design Collaborative Centre Institut Teknologi Sepuluh November (ITS)	Vice Chair Department of Electrical Engineering	Astria Nur Irfansyah
10.	Educational Institution	State Vocational High School 1 Semarang	External Relations and Electronics Major Teacher	Sunar
11.	Educational Institution	State Vocational High School 3 Tanjungpinang	Headmaster	Samsul Hadi
12.	Educational Institution	Batam State Polytechnic	Director, Supervisor of Teaching Factory Manufacturing of Electronics, Head of Electronics Manufacturing	Bambang Hendrawan, Basuki Rachmatul Alam, Muhammad Arifin
13.	Environmental Analyst	The Indonesian Forum for Environment (WALHI)	Spatial and Infrastructure Campaign Manager	Dwi Sawung

Annex D

Consultative Workshop: Indonesia's Semiconductor Industry – Towards Realising the Potential for Growth

The Consultative Workshop: Indonesia's Semiconductor Industry – Towards Realising the Potential for Growth was a key phase in the analytical series conducted by the research team from LPEM FEB UI, in collaboration with the Foreign, Commonwealth, and Development Office of the United Kingdom (FCDO UK). The workshop was held on Wednesday and Thursday, 26-27 February 2025, in Bogor, Indonesia. The primary objective of the consultative workshop was to capture perspectives from various stakeholders, including government representatives, industry players, and academic institutions. There are 23 participants that were joining the session. List of consultative workshop participants are available below:

No.	Name	Institution
1.	*Anonymous representative*	AiTI Indonesia
2.	Joegianto	Polytron
3.	*Anonymous representative*	The Coordinating Ministry for Economic Affairs
4.	Samuel Hayes, Fenna Marliasari, Askar M.	British Embassy
5.	Syafrudi	Prasetya Mulya University
6.	Putu Nadi A., Rizki Triana P., Abdillah Einstein, Novriadi Tri K., Ceci Hani H.	The Ministry of Industry
7.	Britantyo Wicaksono and A. Tossin	State Polytechnic of Jakarta (PNJ)
8.	Suroto and Asghori	Vocational Teacher School of Cikini (SMK Perguruan Cikini)
9.	Yodo M. and I.B. Ngesti Dewa M.	PPISI
10.	Robby Kurniawan H.	Gunadarma University
11.	Lukito Wijaya	AIPTI
12.	D. Sawung	WALHI
13.	Rizki Ardianto P.	Telkom University
14.	Nur Ersandi	The Ministry of Manpower
15.	F. Ihsan Hariadi	Bandung Institute of Technology
16.	Mia Galina	President University
17.	M. Mustafa Sarinanto	The Ministry of Manpower
18.	Ashintya Damayati, Immanuel Bhimadjaja, Faradina Alifia Maizar, Nia Kurnia Sholihah, Andreas Alfonsus, Anita Putri, Difa Fitriani, Gerald Ezra, Fitri Nurjanah, Dwi Sulistyorini, Rifa Eka Rozani, Ali Kifayatullah	LPEM FEB UI (Organiser)

A total of 23 participants were divided into 2-3 small teams to discuss the following key topics:

1. Defining the Semiconductor Industry in Indonesia. Participants engaged in discussions to refine and enhance the existing definition and scope of the semiconductor ecosystem in Indonesia, incorporating insights from various stakeholders.

2. **PESTEL Analysis.** An initial reflection on the Political, Economic, Social, Technological, Environmental, and Legal (PESTEL) factors influencing the semiconductor sector was conducted. This provided a comprehensive understanding of the external environment shaping the industry.

3. **Market Trend Analysis.** This session focused on analysing market growth, competition, comparative advantages, product and service evolution, and pathways to market entry across four dimensions: domestic market, regional market, advanced economies, and the global market.

4. **Visioning the Future.** Participants articulated a vision for Indonesia's semiconductor industry, defining both short-term and long-term goals and aspirations.

5. **Gap Analysis.** After establishing a long-term vision, participants identified gaps between the current state and the desired future state. This exercise provided a clear understanding of the key challenges that need to be addressed to achieve the vision.

6. **SWOT (Strengths, Weaknesses, Opportunities, and Threats) Analysis**
   The research team prepared a preliminary SWOT analysis based on literature reviews and in-depth interviews. Participants reviewed and refined the SWOT analysis in small groups. Following group discussions, the top 10 indicators for each SWOT category were selected. The final outcome was a comprehensive SWOT table, reflecting collective input and priorities from all participants.

7. Strategic Prioritisation. After finalising the SWOT analysis, the workshop proceeded to determine strategic priorities using the Internal Strategic Factor Analysis Summary (IFAS) and External Strategic Factor Analysis Summary (EFAS) methodologies. These frameworks were used to evaluate internal factors (Strengths and Weaknesses) and external factors (Opportunities and Threats). Participants assessed and validated these factors in small group discussions, assigning weights to reflect strategic importance (with total internal and external factor weights summing to 1) and ratings based on a Likert scale (1 = poor to 4 = very good). The results of this assessment guided the identification of strategic priorities, focusing on:
   a. **S-O (Strength-Opportunity):** Leveraging strengths to capitalise on opportunities.
   b. **W-O (Weakness-Opportunity)**: Addressing weaknesses to seize opportunities.
   c. **S-T (Strength-Threat):** Using strengths to mitigate threats.
   d. **W-T (Weakness-Threat):** Minimising weaknesses to counteract threats.

8. **Strategy Formulation.** The final step involved translating these strategic choices into actionable plans for short-term, medium-term, and long-term implementation. This ensured that the strategies were not only practical and achievable in the short term but also sustainable and forward-looking in the long run. During this session, participants categorised strategies into three timeframes:

a. **Short-term (0-3 years)**: Immediate actions that deliver quick results, address urgent needs, and lay the foundation for further development.

b. **Medium-term (4-5 years):** Initiatives that build on short-term successes and prepare for long-term growth.

c. **Long-term (6-10 years):** Sustainability-focused strategies to ensure long-term alignment with the industry's vision.

The insights and strategies generated from this workshop will serve as critical inputs for the comprehensive roadmap for the development of Indonesia's semiconductor industry, guiding stakeholders in fostering a competitive and sustainable industry ecosystem.






Annex E

The Technology Gaps in Materials Processing

The development of Indonesia's semiconductor industry is hindered not only by infrastructure constraints but also by gaps in technological capabilities, particularly in the processing and refinement of critical raw materials. While Indonesia has abundant natural resources such as quartz sand, bauxite, and zinc, the country lacks the necessary technology to refine these materials into high-purity inputs for semiconductor manufacturing.

Indonesia already has the technology for quartz grinding but does not yet have the technology for purifying quartz sand. Ball mills and quartz crushers are used in the grinding process to reduce the size of quartz into small rocks. In general, Indonesia has this technology that mostly comes from China and the USA. Rotary kilns and fluidised bed furnaces, which are heating machines that support the quartz purification process, already exist. However, this technology is widely used in the nickel and cement industries. Meanwhile, Fluidised Bed Reactor (FDR) technology that is used in the process of purifying quartz sand into high-purity silicon is still not available. It is because the manufacture of this tool involves a fairly complex design.

Similarly, the technology for extracting gallium from industrial residues, such as ion-exchange technology, has not been developed domestically. Although gallium extraction from zinc ore and bauxite has been established globally since the mid-20th century, the process requires sophisticated technology, limiting its adoption to a few advanced companies [85]. One of the most effective technologies for separating gallium from Bayer solution is ion-exchange technology, which has the advantages of a simple process, the amount of gallium that can be extracted, and easy operation [86].

Indonesia also faces limitations in the extraction of germanium, a critical material used in semiconductor applications. Due to the scarcity of zinc processing facilities, technological advancements in germanium extraction remain minimal. The technology supporting Germanium extraction is microwave metallurgy, used for selective, internal, and non-contact heating processes [87]. Microwave metallurgy is used to heat and change the material's structure so that germanium is more soluble while leaching with sulphuric acid dissolves germanium to separate it. With this method, germanium extraction increases to 84.4%, or 22% higher than without microwave roasting [88]. This technology has begun to be modified mainly in the largest Ge-producing country, namely China [89].

Annex F

Historical Perspectives on Semiconductor Strategies in UK

The United Kingdom's National Semiconductor Strategy, which was launched in 2023, was deemed to pioneer its comprehensive and long-term semiconductor strategy. However, prior to that, the UK has also had a long-standing participation in the global semiconductor ecosystem. Since the discovery of transistor in the 1940s, global electronics firms were rapidly adopted the technology, including Plessey and Ferranti in the UK [90]. The UK government has an important role in financing several high-technology companies in early 1960s, including to Marconi-Elliot Microelectronics, Plessey Semiconductors, and Ferranti Semiconductors [91]. The seriousness of the UK government in semiconductors development in 1960s, which was shown by the investment of USD 8 million on the UK semiconductors R&D – equivalent to one third of American research spending on semiconductors.

The UK government within 1960s and 1970s imposed several interventionist measures for their industrial expansion. Along the emergence of other advanced technologies (e.g. integrated circuit), the UK had lost its competitiveness and experienced a downturn in this industry [90]. A contrast industrial strategy with many of its European counterpart contribute to the decline of semiconductor industry in the UK during that time. The research [92] also added that the UK government inconsistency in semiconductors strategy between 1960s and 1990s disincentivised investors to expand semiconductor industry in UK. In 1975, the Labour government initiated the establishment of National Enterprise Board (NEB) which aimed to support industrial policy in UK, including for semiconductors. In the effort to help semiconductor industry in UK, NEB did several strategic initiatives, including the provision of GBP 50 million to establish a US-UK joined semiconductor firm, Inmos, which focused on microprocessor fabrication and design of memories [92]. Direct intervention of the UK government during 1970s was highlighted by the launching of Microelectronics Industry Support Scheme (MISP) and Microprocessor Applications Project (MAP) which aimed to develop the production of ICs and have been estimated to fund IC projects for GBP 250 million [93]. The role of the UK Ministry of Defence, aside from industrial funding, was also pivotal in semiconductor research and development (R&D), marked by the establishment of Royals Signals and Radar Establishment (RSRE) in 1975 – a leading R&D institution for semiconductors.

Following the political regime transition in the late 1970s, the UK industrial strategy turned from interventionist measures to privatisation and foreign ownership in domestic industries. Although this strategy cannot effectively develop large semiconductor manufacturers, there had been a quite expansion in UK's semiconductors, including the establishment of Arm in 1990, which now has become the largest semiconductor and software design firm based in the UK. This market-oriented regime was also affected academia, including the strengthening of research cooperation between universities and industries. In 1982, the UK government launched the Alvey programme, a five-year research initiative on semiconductors, which deemed had successfully coordinated the UK research on semiconductor latest technologies and was effectively bridged universities and industries [94].

Although relatively had slow progress and incomprehensive semiconductor-related policies, the UK had developed several firms and clusters of semiconductors until 2020s. Until now, there are several clusters which are used for semiconductor production and design, including Bristol, Cambridge, Northeast England (manufacturing), Northern Ireland, Scotland (manufacturing), and South Wales (manufacturing) [95]. In 2022, the UK semiconductor companies' revenues had reached GBP 9.6 billion which account for 2% of global semiconductor revenue, with 85% of the UK semiconductor revenues were contributed from chip design [95]. The UK relatively only has small capacity in semiconductor fabrication, with only roughly 25 semiconductor fabrication, including in university-based fabrication [96]. With a quite significant of foreign ownership in domestic semiconductor industry, the UK government raise their concerns on national security by imposing National Security and Investment Act in January 2022 to regulate foreign investment [90].

Annex G

SWOT Analysis

The SWOT analysis of Indonesia's semiconductor industry applies two assessment stages to each identified factor: rating (impact/magnitude) and weight (urgency of resolution). The rating evaluates the extent to which a factor influences the industry's development, while the weight reflects the urgency of addressing the factor within the industrial strategy. Both assessments utilise a Likert scale of 1 to 4.

The rating scale ranges from 1 to 4, where 1 indicates minimal impact on the industry, while 4 denotes a highly influential factor that significantly shapes the sector's trajectory. For example, "Interstate technology competition" may be assigned a rating of 4 due to its substantial effect on Indonesia's semiconductor industry competitiveness. In contrast, a factor such as "Growing government support" might receive a rating of 3, as it is important but not the sole determinant of industry growth. This classification facilitates the prioritisation of factors based on their relative influence, ensuring a focused approach to strategic planning.

The weighting scale similarly ranges from 1 to 4, where 1 signifies that a factor is not an immediate priority, whereas 4 highlights a pressing issue requiring urgent attention. For instance, "Policy uncertainty and political willingness" may receive a weight of 4, as inadequate political commitment could impede industry progress. Conversely, "Abundant natural resources" may be assigned a weight of 2, as it remains relevant but does not require immediate resolution. The weighting process ensures that industry stakeholders concentrate on the most critical areas for intervention.

The results from the rating and weight assessments are then incorporated into the IFAS (Internal Factor Analysis Summary) and EFAS (External Factor Analysis Summary) calculations. These scores help determine the strategic position of the Indonesian semiconductor industry within the SWOT framework, identifying key strengths, weaknesses, opportunities, and threats. By leveraging these insights, decision-makers can formulate the most effective strategy to enhance the industry's competitiveness and long-term sustainability.

Following the rating and weighting assessments, the IFAS (Internal Factor Analysis Summary) and EFAS (External Factor Analysis Summary) matrices were used to quantify the semiconductor industry's internal and external conditions. This step involved aggregating the weighted scores of strengths, weaknesses, opportunities, and threats to establish an industry positioning framework.

Internal Factor Analysis Summary (IFAS)

Internal Factor Analysis Summary (IFAS) analysis was used to assess the internal factors affecting the Indonesian semiconductor industry. Each factor in the Strengths (S) and Weaknesses (W) categories was assessed based on the rating, weight, and score, which were obtained from the respondents' questionnaire results. The IFAS table presents internal factors in descending order based on their final scores.

Questionnaire Result Data and Internal Factor Score Calculation (IFAS)

No	Strength & Weakness	Rating				Tota l	Rating	Weight				Questionnaire Data Processing	Weight	Score
		1	2	3	4			1	2	3	4			
Strength														
1	Growing government support	0	0	1	10	43	4	0	0	1	10	43	0.13	**0.52**
2	Demographic dividend	0	0	10	1	34	3	0	3	6	2	32	0.1	**0.3**
3	Abundant natural resources	0	2	5	4	35	3	2	2	3	4	31	0.09	**0.27**
											Strength Total	**106**	**0.32**	**1.09**
Weakness														
1	Deficiency on the availability and quality of infrastructure	0	1	1	9	41	4	0	0	3	8	41	0.12	**0.48**
2	Inconsistencies in government regulations	0	0	4	7	40	4	0	0	3	8	41	0.12	**0.48**
3	Lack of business leadership	1	0	2	8	39	4	0	0	4	7	40	0.12	**0.48**
4	Fragmented semiconductor ecosystem	0	0	5	6	39	4	0	0	3	8	41	0.12	**0.48**
5	Limitations in curriculum support	1	1	4	5	35	3	1	1	5	4	34	0.1	**0.3**
6	Lack of customs officers' information of good product classification	2	1	4	4	32	3	0	3	6	2	32	0.1	**0.3**
											Weakness Total	**229**	**0.68**	**2.52**
											IFAS Total	**335**	**1**	**3.61**

Source: Consultative workshop conducted by LPEM FEB UI (2025)

The ratings in IFAS reflect the extent to which a factor affects the semiconductor industry. The rating value is calculated by taking the average of the total respondents' answers and rounding up to the nearest number on a Likert scale of 1-4. For example, the factor **“Growing government support”** has a total respondent answer of 43 with 11 respondents, so the rating calculation is **43 ÷ 11 = 3.91, which is then rounded to 4.** The higher the rating of a factor, the greater its influence on the semiconductor industry.

Once the rating and weight values are obtained, the score is calculated by multiplying the two values. For the factor “Strong support from the government”, **with a rating of 4 and a weight of 0.13, the score is calculated as 0.13 × 4 = 0.52.** This score indicates the factor's contribution to the overall IFAS total. Through this calculation, the total score for each Strengths (S) and Weaknesses (W) category is obtained, which is then used to determine the position of the Indonesian semiconductor industry in the SWOT analysis. The IFAS results will be combined with the EFAS (External Factor Analysis Summary) calculation to produce a strategy that best suits the current state of the industry.

External Factor Analysis Summary (EFAS)

An External Factor Analysis Summary (EFAS) analysis was used to assess the external factors affecting the Indonesian semiconductor industry. These

factors were categorised into opportunities (Opportunities - O) and threats (Threats - T). Each factor was assessed based on the rating, weight, and score, which were obtained from the respondents' questionnaire results. The EFAS table presents external factors in descending order based on their final scores.

Questionnaire Result Data and External Factor Score Calculation (EFAS)

No	Opportunity & Threat	Rating				Total	Rating	Weight				Questionnaire Data Processing	Weight	Score
		1	2	3	4			1	2	3	4			
Opportunity														
1	Chip-war	0	1	5	5	37	3	0	1	5	5	37	0.11	**0.33**
2	Technological disruption	0	1	5	5	37	3	1	1	5	4	34	0.11	**0.33**
3	New investment policy alternative	1	2	5	3	32	3	1	0	6	4	35	0.11	**0.33**
4	Indonesia's neutral position for investment	0	2	6	3	34	3	0	2	6	3	34	0.1	**0.3**
5	The growth of the digital lifestyle	1	0	4	6	37	3	2	0	7	2	31	0.1	**0.3**
Opportunity Total												**171**	**0.53**	**1.59**
Threat														
1	Policy uncertainty and political willingness	0	0	0	11	44	4	0	0	0	11	44	0.14	**0.56**
2	Intensifying global technological competition	0	0	7	4	37	3	0	0	4	7	40	0.12	**0.36**
3	Minimal local workforce involvement	1	1	7	2	32	3	1	0	6	4	35	0.11	**0.33**
4	Lack of industry cluster to attract investment	0	1	7	3	35	3	1	1	5	4	34	0.1	**0.3**
Threat Score												**153**	**0.47**	**1.55**
EFAS Total												**324**	**1**	**3.14**

Source: Consultative workshop conducted by LPEM FEB UI (2025)

The rating in EFAS indicates the level of influence a factor has on the semiconductor industry. The rating value is calculated by taking the average of the total respondents' answers, then rounded to the nearest number on a Likert scale of 1-4. For example, the factor **"The growth of digital lifestyle"** has a total respondent answer value of 37 with a total number of 11 respondents, so the rating calculation is **37 ÷ 11 = 3.36, which is then rounded to 3.** The higher the rating of a factor, the greater its impact on the industry.

Meanwhile, the weight in EFAS illustrates the level of urgency of a factor for immediate action in the semiconductor industry strategy. The weight is calculated by comparing the total respondents' answers for one factor to the total EFAS data. In the same example, the total questionnaire data processing score for the factor **"The growth of digital lifestyle" is 31,** while the **total number of factors in the EFAS is 324.** Thus, the weight is calculated as **31 ÷ 324 = 0.10.** The greater the weight value, the more urgent the factor is to be immediately prioritised in the industrial strategy.

Once the rating and weight values are obtained, the score is calculated by multiplying the two values. For the factor **"The growth of digital lifestyle", with a rating of 3 and a weight of 0.10**, the score is calculated as **0.10 × 3 = 0.30.** This score indicates the factor's contribution to the overall EFAS total. Through this calculation, the total score for each category of Opportunities (O) and Threats (T) is obtained, which is then used to determine the position of the Indonesian semiconductor industry in the SWOT analysis. The EFAS results will be combined with the IFAS calculation to produce a strategy that best suits the current state of the industry.

The total results of the IFAS and EFAS matrix score calculations are as follows:

- Total score of **strengths = 1.09**
- Total score of **weaknesses = 2.52**
- Total score of **opportunities = 1.59**
- Total score of **threats = 1.55**

Analysis of IFAS and EFAS Results: Determination of Strategy Based on SWOT

After calculating the ratings, weights, and scores in IFAS and EFAS, the next step is to determine the strategic coordinates of the semiconductor industry using the Cartesian Diagram and SWOT Matrix approaches.

1. Internal and External Analysis Coordinates

This analysis coordinate is calculated by comparing the total score of strength (S) and weakness (W) factors for internal aspects, and the total score of opportunity (O) and threat (T) factors for external aspects.

- $X = \frac{Total\,Strength\,Score - Total\,Weakness\,Score}{2}$
- $X = \frac{1.09 - 2.52}{2} = -0.72$

Negative values indicate that weaknesses are more dominant than strengths in the Indonesian semiconductor industry.

- **External coordinate calculation (O - T):**
  - $$Y = \frac{Total\,Opportunity\,Score - Total\,Threat\,Score}{2}$$
  - $$Y = \frac{1.59-1.55}{2} = 0.02$$

A positive value indicates that opportunities are still greater than threats, although the difference is relatively small.

The final coordinates of this analysis are (-0.72; 0.02)

2. SWOT Cartesian Diagram

The Cartesian SWOT diagram divides strategies into four quadrants, namely:

- **Quadrant I (Growth - SO):** Industry conditions that have great strengths and opportunities, the strategy used is aggressive (expansive growth).
- **Quadrant II (Stability - WO):** Industry conditions that have more dominant weaknesses, but still have opportunities, the strategy used is to take advantage of opportunities to improve weaknesses.
- **Quadrant III (Defensive - WT):** Industry conditions with dominant weaknesses and threats, the strategy used is to minimise risk and survive.
- **Quadrant IV (Diversification - ST):** Industry conditions with high strengths but facing major threats, the strategy used is diversification or innovation to overcome threats.

Based on the coordinates **(-0.72; 0.02), the Indonesian semiconductor industry is in Quadrant II (Stability - WO).** This means that the most relevant strategy is **to improve weaknesses by utilising available opportunities.**

3. Result of the SWOT Strategy Analysis

No.	Weakness (W)	Opportunity (O)	WO Strategy
1.	W1. Deficiency on the availability and quality of infrastructure	O3. New investment policy alternative	Encouraging investment from various sources, including innovative financing mechanisms, public-private partnerships (PPP), and sovereign wealth funds (SWF), to support the development of semiconductor industry infrastructure, including the construction of manufacturing facilities and research centres.
2.	W1. Deficiency on the availability and quality of infrastructure	O4. Indonesia's neutral position for investment	Leveraging Indonesia's neutral position to attract foreign investment, which can be used to accelerate the development of semiconductor industry infrastructure.
3.	W2. Inconsistencies in government regulations	O4. Indonesia's neutral position for investment	Harmonising national policies related to the semiconductor industry by utilising Indonesia's attractiveness as a neutral location for foreign investors.

No.	Weakness (W)	Opportunity (O)	WO Strategy
4.	W3. Lack of business leadership	O3. New investment policy alternative	Encouraging business leadership initiatives through acceleration programmes and government-supported funding to accelerate the development of the semiconductor ecosystem in Indonesia.
5.	W4. Fragmented semiconductor ecosystem	O1. Chip-war	Developing the semiconductor industry ecosystem by attracting investment from countries affected by the chip war, making Indonesia an alternative in the global supply chain.
6.	W4. Fragmented semiconductor ecosystem	O2. Technological disruption	Encouraging innovation and strengthening the local supply chain in the semiconductor industry to adapt to the rapid developments in global technology disruption.
7.	W4. Fragmented semiconductor ecosystem	O5. The growth of digital lifestyles	Increasing domestic demand for semiconductor products by utilising digitalisation and the adoption of increasingly widespread technology.
8.	W5. Limitation in curriculum support	O4. Indonesia's neutral position for investment	Utilising foreign investment potential to support knowledge transfer, training, and workforce capacity development in the semiconductor industry.
9.	W6. Lack of customs officers' information of good and product classification	O4. Indonesia's neutral position for investment	Enhancing the capacity of customs officers through training and benchmarking to other countries that have more advanced awareness systems for handling semiconductor sector products.

Source author's compilation based on consultative workshop

Annex H

Roadmap for Indonesia's Semiconductor Industry

Value Chain		Short Term 2 – 3 Years	Medium Term 4 – 5 Years	Long Term 6 – 10 Years
Materials	Strategy	i. Expansion of Photovoltaic (solar Grade) Silicon Wafer Production through domestic and foreign investment ii. Expansion of Electronic Grade Silicon Wafer Production through domestic and foreign investment	i. Expansion of Photovoltaic (solar Grade) Silicon Wafer Production through domestic and foreign investment a. Investment in Smelter Silica Electronic Grade, Gallium Nitride b. Investment on Polysilicon Electronic Grade, Gallium Nitride Industry ii. Facilitating technology transfer through collaboration with local partners in material processing iii. Initiating research and development in material processing	i. Expansion of Photovoltaic (solar Grade) Silicon Wafer Production through domestic and foreign investment a. Investment on Smelter Silica Electronic Grade, Gallium Nitride b. Investment on Polysilicon Electronic Grade, Gallium Nitride Industry ii. Advancing research and development in material processing
	Stakeholder	i. Ministry of Energy and Mineral Resources ii. Ministry of Industry iii. Ministry of Investment iv. Ministry of Foreign Affairs v. Ministry of Finance, Directorate General of Customs and Excise vi. Domestic and Foreign Companies	i. Ministry of Higher Education, Science, and Technology ii. Ministry of Energy and Mineral Resources iii. Ministry of Industry iv. Ministry of Investment v. Ministry of Foreign Affairs vi. Ministry of Finance, Directorate General of Customs and Excise vii. Domestic and Foreign Companies	i. Ministry of Higher Education, Science, and Technology ii. Ministry of Energy and Mineral Resources iii. Ministry of Industry iv. Ministry of Investment v. Ministry of Foreign Affairs vi. Ministry of Finance, Directorate General of Customs and Excise vii. Domestic and Foreign Companies

Value Chain		Short Term 2 – 3 Years	Medium Term 4 – 5 Years	Long Term 6 – 10 Years
Design	Strategy	i. Incentives to strengthen existing design houses and establish new ones ii. Human Resource Development (incl. scholarship and internship) iii. Collaboration with international universities iv. Provision of collaborative design tools	i. Human Resource Development (incl. scholarship and internship) ii. IC Design Production collaborating with leading semiconductor company iii. Development of licensed IC chip production capabilities iv. Establishment of competency standards for IC design	i. Becoming a semiconductor talent centre to support a competitive design industry ii. Capability to produce licensed IC chips
	Stakeholder	i. Ministry of Finance ii. Ministry of Industry iii. Ministry of Higher Education, Science, and Technology iv. National Research and Innovation Agency v. ICDeC	i. Ministry of Finance ii. Ministry of Industry iii. Ministry of Higher Education, Science, and Technology iv. National Research and Innovation Agency v. Ministry of Law and Human Rights, Directorate General of Intellectual Property vi. National Professional Certification Agency vii. Educational Institution viii. ICDeC ix. Private Foreign Company	i. Ministry of Manpower ii. Ministry of Industry iii. Ministry of Higher Education, Science, and Technology iv. National Research and Innovation Agency v. Ministry of Law and Human Rights, Directorate General of Intellectual Property vi. National Professional Certification Agency vii. Educational Institution viii. ICDeC
Fabrication	Strategy	i. Developing Detailed Engineering Design and conduct feasibility study ii. Finding global partner: a. Finding technology provider b. Finding equipment provider c. Finding investment	i. Technological transfer ii. Pilot-scale production of wafer fabrication for domestic industry (secure module, sensor, audio, microcontrollers chip more than 28 nanometres)	i. Small-scale factory commercialisation of wafer fabrication for domestic industry (secure module, sensor, audio, microcontrollers chip more than 28 nanometres) ii. Production and transfer technology in wafer fabrication (microprocessor, graphic processor, memory)

Annex H

Roadmap for Indonesia's Semiconductor Industry

Value Chain		Short Term 2 – 3 Years	Medium Term 4 – 5 Years	Long Term 6 – 10 Years
	Stakeholder	i. Ministry of Industry ii. Ministry of Investment iii. Ministry of Foreign Affairs iv. Domestic and Foreign Companies	i. Ministry of Industry ii. Ministry of Investment iii. National Research and Innovation Agency iv. Domestic and Foreign Companies	i. Ministry of Industry ii. Ministry of Investment iii. National Research and Innovation Agency iv. Domestic and Foreign Companies
Assembly, Testing, and Packaging (ATP)	Strategy	i. Encouraging new investment in ATP or expansion ii. Local partnership policies in the high-tech industry iii. Facilitating the improvement of local human resources quality (inc. vocation, training, teaching factory)	i. Strengthening investment in ATP or expansion ii. Stimulating market expansion to absorb locally produced semiconductors	Semiconductor industry ATP independence
	Stakeholder	i. State-Owned/Private Companies ii. Ministry of Finance iii. Ministry of Industry iv. Ministry of Investment v. Ministry of Manpower vi. Ministry of Primary and Secondary Education vii. Educational Institution	i. Ministry of Industry ii. Ministry of Trade iii. Ministry of Investment iv. State-Owned/Private Companies	i. Ministry of Industry ii. Ministry of Trade iii. Ministry of Investment iv. State-Owned/Private Companies

Annex I

Role of Stakeholders in Indonesia's Semiconductor Industry:

Stakeholder	Materials			Design			Fabrication			ATP		
	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
Ministry of Energy and Mineral Resources	Ensuring the availability of high-purity silicon by supporting sustainable extraction and refining of raw materials.	Ensuring the availability and efficient utilisation of raw materials for semiconductor-grade processing.	Ensuring the sustainable supply and efficient utilisation of raw materials for semiconductor production.									
Ministry of Industry	Facilitating industrial policies, providing regulatory support, and ensuring alignment with national manufacturing priorities.	Providing industrial policies and regulatory frameworks to facilitate material processing investments.	Establishing industrial policies and incentives to support large-scale material processing investments.	Establishing industrial policies and regulatory framework for chip design production (including R&D and human capital)	Formulating industrial policies and regulatory support for licensing and establishment of chip designs competency standard	Formulating long-term industrial policies and regulatory support for chip design production by coordination with related ministries	Facilitating policy support, provides regulatory guidance, and ensures alignment with national industrial development plans.	Providing policy direction, regulatory support, and facilitates industrial development initiatives to enhance local fabrication capacity.	Developing policies and regulatory frameworks to support the commercialisation of wafer fabrication and the expansion of domestic production capabilities.	Developing policies and regulatory frameworks to support ATP expansion and integration within the broader semiconductor ecosystem.	Developing policies and regulatory frameworks to support ATP expansion and ensure the sector's alignment with industrial development priorities.	Establishing industrial policies that facilitate the full integration of ATP capabilities into Indonesia's semiconductor ecosystem.
Ministry of Investment	Promoting Indonesia as an attractive destination for silicon wafer investment and facilitating investor commitments.	Promoting Indonesia as a hub for advanced material processing and securing commitments from foreign investors.	Facilitating long-term investment in high-value semiconductor material production and research.				Promoting Indonesia as an attractive destination for semiconductor investment and assists in securing commitments from potential investors.	Attracting investment from both domestic and international players to support technology transfer and pilot production efforts.	Facilitating investment in semiconductor manufacturing infrastructure, attracting both domestic and foreign investors to establish and expand fabrication facilities.	Facilitating domestic and foreign investment in ATP, ensuring alignment with Indonesia's industrial and economic development goals.	Attracting domestic and foreign investors to scale up ATP operations through investment incentives and policy support.	Driving investment strategies to support the growth of ATP facilities and encourage long-term industry sustainability.
Ministry of Foreign Affairs	Engaging in diplomatic efforts to secure international partnerships, technology transfers, and supply chain cooperation.	Facilitating international collaboration, including technology transfer agreements and strategic partnerships.	Strengthening international collaboration and securing strategic partnerships in material technology.				Engaging in diplomatic efforts to establish international partnerships, negotiate technology transfers, and strengthen Indonesia's position in the global semiconductor ecosystem.					

Stakeholder	Materials			Design			Fabrication			ATP		
	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
Ministry of Finance, Directorate General of Customs and Excise	Implementing fiscal incentives, tax policies, and import duty regulations to support the competitiveness of domestic production.	Implementing financial incentives and regulatory support to enhance industry competitiveness.	Providing fiscal incentives and trade policies to enhance the competitiveness of locally processed semiconductor materials.							Providing fiscal incentives, including tax benefits and subsidies, to attract ATP investments and facilitate industry growth.		
Ministry of Finance				Formulating fiscal incentives (tax, subsidies) for investment in the chip design production	Formulating fiscal incentives (tax, subsidies) for investment in the chip design production, specifically incentive supports for licensing and establishment of chip designs competency standard							
Ministry of Primary and Secondary Education										Strengthening technical education programmes to create a pipeline of talent for the semiconductor industry.		
Ministry of Higher Education, Science, and Technology		Supporting R&D initiatives and developing specialised talent for semiconductor material processing.	Driving long-term R&D efforts and developing specialised talent for advanced material processing.	Designing the specific education and research policies for chip design, providing scholarship for Indonesians to pursue higher education programme abroad, and fostering collaboration with international universities	Mapping the talent for chip design and fostering collaboration with global semiconductor design firms to establish competency standards for chip design	Designing education and research policies to support chip design industries in Indonesia						

Stakeholder	Materials			Design			Fabrication			ATP		
	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
Ministry of Manpower						Designing policies, incentives schemes, and regulatory frameworks for establishment of semiconductor talent centre in Indonesia				Overseeing workforce development programmes, including skill enhancement initiatives tailored to ATP operations.		
Ministry of Trade											Facilitating market access for Indonesian semiconductor products, negotiating trade agreements, and promoting exports.	Expanding market access for domestically produced semiconductors and ensuring competitiveness in international trade.
The National Research and Innovation Agency				Formulating blueprint for chip design research and foster collaboration with international research centre for chip design	Providing policy support for licensing and incentivising all chip design production to have licence	Providing policy support for licensing and incentivising all chip design production to have licence		Supporting research and development activities, fosters collaboration between industry and academia, and ensures technological readiness for semiconductor fabrication.	Supporting research and development initiatives to advance semiconductor fabrication technology and ensures knowledge transfer to local industries.			
Ministry of Law and Human Rights, Directorate General of Intellectual Property					Providing guidance and regulatory framework for the intellectual property applications for chip design	Continue to provide sound regulatory framework for intellectual property to strengthen the semiconductor talent centre						
National Professional Certification Agency					Providing guidance and regulatory framework for the establishment of chip design competency standard	Continue to provide guidance and regulatory framework for the establishment semiconductor talent centre						

Stakeholder	Materials			Design			Fabrication			ATP		
	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
Domestic and Foreign Companies	Acting as key investors, technology providers, and industrial partners, bringing expertise, infrastructure, and capital to support production expansion.	Acting as key investors, technology providers, and research collaborators, bringing expertise, infrastructure, and funding to strengthen downstream material processing.	Acting as key investors, technology providers, and industrial partners, contributing expertise, infrastructure, and capital to drive long-term industry growth.				Acting as technology providers, equipment suppliers, and investment partners, bringing in the necessary expertise, infrastructure, and capital to support fabrication development.	Acting as technology providers, investment partners, and operational leaders in pilot-scale production, contributing expertise and infrastructure for the development of the semiconductor industry.	Providing technological expertise, capital investment, and operational capabilities to develop and commercialise semiconductor production within Indonesia.			
State-owned/private companies (including start-up)										Leading investment initiatives, establishing ATP facilities, and developing partnerships for technology acquisition and capacity building.	Leading investment in ATP infrastructure, fostering technology partnerships, and driving the commercialisation of locally produced semiconductors.	Leading the development and commercialisation of ATP capabilities, fostering innovation, and ensuring the industry's global competitiveness.
Private Foreign Company					Providing direct investment and technologies in chip design in Indonesia and opportunities for Indonesians to be involved in the chip design production							
Educational Institutions				Providing relevant study programme and curriculum for chip design and foster collaboration with international educational institution	Collaborating with industries and government in the establishment of chip design competency standard	Collaborating with industries and government in the establishment of semiconductor talent centre				Providing specialised training, vocational programmes, and research collaboration to support the ATP industry's workforce needs.		

Stakeholder	Materials			Design			Fabrication			ATP		
	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term	Short-term	Medium-term	Long-term
Academia (ICDeC)				Pooling talent for chip design and providing platform for collaborative research, collaborative design tools, and platform to access any infrastructure needed	Organising coordination mechanism for the licensing application in all chips design industries and coordinating the establishment of chip design competency standard	Building coordination mechanism between universities, government, and industries, providing coordinated access to infrastructure, initiate the establishment of semiconductor talent centre						
Funders and Donors (including Financial Institutions)	Support upstream readiness assessments and fund exploratory research in high-purity materials and critical mineral processing. Facilitate public-private dialogues on resource-based investment strategies.	Provide financing instruments for the establishment of domestic material refining and purification facilities. Offer concessional funding for environmental and feasibility studies.	Anchor long-term capital for scaling advanced materials production and sustainable supply chains. Support green financing models for material extraction and circular economy initiatives.	Fund capacity-building programmes for IC design talent development and early-stage design houses. Provide seed grants to stimulate local design startups and incubators.	Expand financial access to advanced design tools and EDA licences through collaborative funding schemes. Finance university–industry partnerships in design R&D.	Sustain long-term innovation financing through venture funds and IP commercialisation support for mature domestic design firms. Promote global co-investment in Indonesia-based design centres.	Provide early financing instruments for initial feasibility studies. Design financial schemes for joint collaboration of foreign and domestic investors.	Provide blended finance and diversifying/ mobilise private finance for pilot fabrication lines or joint ventures with global foundries. Offer de-risking instruments to crowd in private sector investors.	Serve as long-term financing anchor for full-scale fabrication plants, including support for high-capex investments via equity, loans, and public-private partnership schemes	Finance feasibility studies and support expansion of existing ATP capacity through concessional loans or matching funds.	Facilitate investment in automated testing equipment and workforce upskilling programmes. Enable working capital support for local ATP service providers.	Support scale-up and technological upgrading of ATP facilities to serve global clients. Fund sustainability improvements and integration with regional ATP supply networks.

Source: LPEM FEB UI (2025)

Final
Report

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Indonesia’s Semiconductor Industry - Towards Realising the Potential for Growth