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Semiconductor Human Resource Development Measures and Activities in Korea

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Executive Summary

In recent years, the growing strategic importance of the semiconductor industry has led to increasingly intense competition among major nations for technological supremacy. In this context, enhancing technological competitiveness through the development and retention of skilled talent has become essential for the continued advancement of the semiconductor industry. However, countries such as Japan and South Korea are now confronting a shortage of semiconductor talent, driven by intensified global competition and demographic decline. In response, the South Korean government launched the *Semiconductor-Related Human Resources Development Plan* in 2022, initiating a coordinated effort across ministries and agencies to strengthen talent development. This study examines the current landscape of South Korea's semiconductor industry, with particular focus on the supply and demand of human resources. It further analyzes ongoing public- and private-sector initiatives aimed at addressing these workforce challenges. Through an in-depth review of the background, objectives, and implementation of South Korea's human resources policies, this study seeks to inform the development of future policy approaches in Japan, where similar challenges related to demographic trends and semiconductor workforce shortages are emerging. Chapter 1 examines global semiconductor market trends, followed by an overview of the development history, characteristics, and status of the Korean semiconductor industry within the global market. This analysis confirms that Korea's traditional growth model of semiconductor industry has reached its limits.

In the early 1960s, Korea's semiconductor industry began to grow through state-led technology development and research support. By the 1990s, it had secured a leadership position thanks to large-scale investments in core technologies by major IDMs such as Samsung Electronics and SK Hynix. In the late 2000s, Korea emerged victorious in the global price competition (so-called "chicken game"), successfully gaining dominance in the memory semiconductor market. This development path, centered around Samsung Electronics and SK Hynix, has led to a high dependency on these two companies. While companies specializing in individual processes—such as fabless, foundry, OSAT, and equipment—have recently increased their presence, the overall industrial base outside of memory semiconductors remains weak. More recently, Korea has failed to secure competitiveness in the system semiconductor market, while also losing market share in memory semiconductors due to China's aggressive pursuit, putting the industry at risk of a broader structural crisis.

Chapter 2 identifies the current human resource challenges facing Korea's semiconductor industry and analyzes the implications amid evolving industrial trends. It confirms that human resource shortages are becoming a critical bottleneck that could undermine Korea's future semiconductor competitiveness. Despite continued investments from both the government and private sector to enhance industrial competitiveness, a persistent shortage of skilled semiconductor human resources remains a key obstacle to sustained growth. This shortage stems from an underdeveloped government-led talent infrastructure and an overreliance on training systems focused on intermediate-level, practice-based talent. If the current talent supply trends continue, Korea is projected to face a shortfall of approximately 77,000 semiconductor workers by 2031.

Chapter 3 examines Korea's semiconductor human resource development strategy and implementation system, noting a shift toward broader support types and targets, with a growing focus on the entire industrial ecosystem. Traditionally, Korea's talent policy centered on contract departments, established with major IDMs like Samsung

Electronics to cultivate intermediate-level, practice-oriented talent. These programs were supported by legal changes, such as the 2003 revision of the Industry-Academic Cooperation Act, enabling close cooperation between industry and academia. However, as semiconductor talent shortages became a national-level issue, the Korean government has expanded its role—directly investing public funds to foster both entry-level and advanced-level talent, and to build educational infrastructure. Responsibility has also broadened from the Ministry of Education to five relevant ministries, each designing projects aligned with their roles in areas such as research, industrial needs, SME support, and labor market dynamics. Finally, Chapter 4 draws upon the findings and analyses presented in Chapters 1 through 3 to identify key challenges in South Korea's semiconductor talent development policies and distill three critical implications for Japan as it advances its own semiconductor workforce initiatives. First, South Korea has actively implemented employment-linked contract-based academic programs as a means to prevent talent and technology outflow. These programs emerged in response to corporate concerns about ensuring that trained talent ultimately joins the semiconductor industry. Japan's ongoing efforts to establish collaborative talent development frameworks between higher education institutions and industry should likewise incorporate mechanisms that facilitate the direct and sustained integration of graduates into the semiconductor workforce. Second, South Korea is expanding both entry-level and advanced-level workforce training initiatives aligned with industry needs and tailored to regional supply chain structures. Recognizing the limitations of relying solely on mid-level training through IDM-centered contract programs, South Korea has increasingly pursued a more balanced approach to talent development across skill levels. While Japan is in the process of building talent development systems by type of required expertise, it will be essential to establish an ecosystem that encourages more active corporate participation in education. Lastly, South Korea has strengthened its regional talent development strategy by designating and connecting local hubs to promote industrial growth and workforce availability. The national government has established semiconductor clusters across various regions as part of its broader regional development agenda. In doing so, it has designated key national universities as regional R&D anchors and Seoul National University as the central hub to oversee talent cultivation and research functions. While Japan has similarly promoted regional talent development through industry-academia-government consortia, it may now be necessary to go beyond region-specific initiatives by introducing a national-level coordinating body. This entity could facilitate regular collaboration and information-sharing across regions on research, technology, talent, and infrastructure, ensuring a more integrated and coherent national approach to semiconductor workforce development.

Table of Contents

1 Development Status of South Korea's Semiconductor Industry ····· 1
1.1 Development Status of the Global Semiconductor Industry ····· 2
1.2 Background and Characteristics of the Development of the Korean Semiconductor Industry ····· 6
1.3 Position of the Semiconductor Industry and Future Prospects in South Korea ····· 13
2 Current Situation of Demand for Human Resources in the Semiconductor Industry and the Issues ····· 21
2.1 Type and Talent of Human Resources Required by the Semiconductor Industry ····· 21
2.2 Supply of Human Resources for each Type in the Korean Semiconductor Industry ····· 24
2.3 Current Situation and Future Outlook of Human Resources Demand in the Korean Semiconductor Industry ····· 25
2.4 Issues of Supply and Demand Situation of Human Resources in Korean Semiconductor Industry ····· 27
3 South Korea's Strategy and System for Semiconductor Human Resource Development ····· 32
3.1 Semiconductor Human Resource Development Strategy ····· 33
3.2 Support Structures for Semiconductor Human Resources Development ····· 35
3.3 Promotion Framework for Semiconductor Human Resources Development ····· 35
3.4 Status of Semiconductor Human Resources Development Initiatives ····· 42
3.5 Industry Initiatives for Semiconductor Human Resources Development ····· 65
4 South Korea's Efforts to Secure Global Competitiveness ····· 69
4.1 Strengthening Public-Private Partnership Frameworks for Early Talent Acquisition and Retention ····· 70

4.2 Expanding the Development of Entry-, Intermediate-, and Advanced-level Talent and Revitalizing Industry Participation in Education ····· 71
4.3 Ensuring Balanced Support for Regional Hubs and Establishing Measures to Strengthen Inter-hub Collaboration ····· 72
List of Authors and Acknowledgements ····· 75

1 Development Status of South Korea's Semiconductor Industry

The semiconductor market has shown sustained growth as advanced technologies that require semiconductors have evolved. In particular, the recent development of artificial intelligence (AI) technologies has rapidly accelerated the growth of the high-performance and high-efficiency AI semiconductor market.

Depending on the scope of their manufacturing processes and areas of specialization, semiconductor companies are classified into Integrated Device Manufacturers (IDMs), fabless companies, and foundries. The U.S. has many major companies in both the fabless and IDM sectors. Taiwan is home to Taiwan Semiconductor Manufacturing Company (TSMC), which holds a dominant share of the global foundry market. Meanwhile, South Korea is the headquarters of the world's leading IDMs, including Samsung Electronics and SK Hynix.

Since the late 1980s, Samsung Electronics and SK Hynix have expanded their investments in the memory semiconductor sector, which had relatively low entry barriers and strong government support. By the 1990s, they had secured technological superiority and established a mass-production system. Moving on to the 2000s, the two companies ultimately prevailed in the "game of chicken" with the global memory semiconductor market, competing through continued high-risk investment and—along with Micron Technology (hereafter Micron)—forming a three-company market structure. This structure still exists. However, more recently, Chinese semiconductor manufacturers have acquired production capacity and price competitiveness through large-scale government support, increasing their market share in legacy memory semiconductors[1] and, thereby, heightening the risk of market share erosion for Korean semiconductor companies. Moreover, as the AI market grows, products such as High Bandwidth Memory (HBM), which are increasingly being adopted to capture a technological edge, pose a key challenge: leveraging them as a new growth driver. Consequently, although SK Hynix has quickly succeeded in this effort and has achieved strong performance in HBM despite sluggish legacy memory business, Samsung Electronics' recent performance has stagnated because of its slow response to this challenge, arising from its failure to shift its primary product focus.

With the advancement and increasing specialization of the semiconductor industry, it is crucial for a nation's semiconductor sector to develop; either all industries within the semiconductor ecosystem—including materials, manufacturing equipment and components, along with fabless and foundry businesses—must grow together, or, despite the trend toward specialization, an IDM that encompasses all related industries—including manufacturing equipment—must expand. While Korean IDMs are capable in developing memory semiconductors, they lack competitiveness in system semiconductors and do not sufficiently incorporate peripheral industries, such as manufacturing equipment. Overall, South Korea's semiconductor industry is regarded as fragile because its IDMs are restricted to their core areas of specialization. There is growing recognition that, for the semiconductor industry to advance and sustain growth, it is necessary to strengthen the foundation of the entire ecosystem. In line with this

[1] "Legacy memory semiconductors" refer to semiconductors that do not apply cutting-edge process technologies, and in the case of Korean IDMs, the term mainly denotes products such as DDR4 and LPDDR4 that are manufactured using processes of 28 nm or larger.

view, the government has been announcing a series of policies to support the semiconductor industry's development. Recognizing that securing human resources is essential for industrial development, the government has prioritized, the cultivation of semiconductor talent as an independent policy issue. For the first time in 2022, it announced specific policies for developing human resources in the semiconductor industry.

1.1 Development Status of the Global Semiconductor Industry

1.1.1 Current Status of the Global Semiconductor Market

The global semiconductor market has been growing steadily, driven by the widespread adoption of advanced technologies that have high semiconductor demand, such as AI, communication technologies, electric vehicles, cloud computing and the Internet of Things (IoT). During the COVID-19 pandemic, a semiconductor boom occurred owing to increased demand for communication devices and related products. However, semiconductor demand slowed when the effects of this boom subsided in 2023. At the same time, heightened global inflation and rising geopolitical risks led to a decline in private consumption and capital investment, resulting in a temporary stagnation of growth. Nevertheless, by 2024, the market had recovered to a level that exceeded its 2022 scale. According to estimates by the World Semiconductor Trade Statistics (WSTS), which publishes annual semiconductor industry statistics, the semiconductor industry grew 19% in 2024, surpassing the 13.1% growth rate forecast at the end of 2023, indicating that the market is expanding more rapidly than predicted.

As AI technologies—which consume enormous amounts of energy to process massive volumes of data rapidly—have advanced quickly in recent years, the market for high-performance, high-efficiency AI semiconductors has been expanding at a remarkable pace (Figure 1-1). In the field of system semiconductors, Neural Network Processing Units (NPUs), which provide far greater large-scale parallel processing capabilities than conventional Central Processing Units (CPUs), as well as neuromorphic chips that utilize analog signal processing to achieve high energy efficiency, are being developed. In the field of memory semiconductors, HBM—an ultra-high-speed DRAM capable of processing data both efficiently and rapidly—has been created. According to the market research firm, Gartner, the global AI semiconductor market is projected to grow from approximately 53.7 billion USD in 2023 to about 159 billion USD in 2028, with an average annual growth rate of around 24.3%.

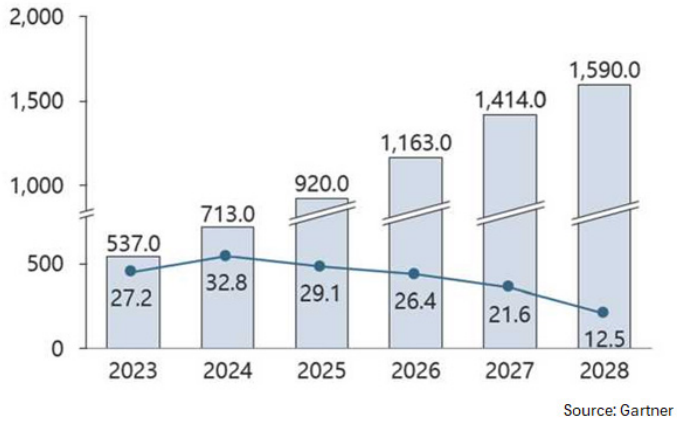


Figure 1-1 Outlook for the Global AI Semiconductor Market Size and Growth Rate
(Unit: 100 million USD, %)

1.1.2 Current Status of Major Global Semiconductor Companies

The global semiconductor market is led by companies that design and manufacture semiconductor products for next-generation technologies such as AI (see Table 1-1). Among the top ten companies by sales, five are U.S. firms, all primarily fabless. Among major Asian countries, South Korea's two major IDMs, Samsung Electronics and SK Hynix, rank third and seventh in sales, respectively, whereas Taiwan's TSMC, a global foundry leader, holds the top position.

Table 1-1 Semiconductor Sales Ranking of Major Global Semiconductor Companies (2023)

Ranking	Company	Type	Headquarters	Revenue (in million U.S. dollars)
1	TSMC	Foundry	Taiwan	69,279
2	Intel	IDM	U.S.	51,505
3	Samsung Electronics	IDM	South Korea	50,904
4	NVIDIA	Fabless	U.S.	49,618
5	Qualcomm	Fabless	U.S.	30,913
6	Broadcom	Fabless	U.S.	29,950
7	SK Hynix	IDM	South Korea	25,006
8	AMD	Fabless	U.S.	22,680
9	Infineon	IDM	Germany	17,364
10	ST	IDM	Switzerland	17,239
11	Micron	IDM	U.S.	16,711
12	TI	IDM	U.S.	16,651
13	Apple	Fabless	U.S.	16,500
14	MediaTek	Fabless	Taiwan	13,891
15	NXP	IDM	Netherlands	13,033
16	Analog Devices	IDM	U.S.	11,778
17	Sony	Fabless	Japan	10,997
18	Renesas	IDM	Japan	10,386
19	Microchip	Fabless	U.S.	8,410
20	ONSEMI	IDM	U.S.	8,253
21	GlobalFoundries	Foundry	U.S.	7,392
22	UMC	Foundry	Taiwan	7,146
23	Kioxia	IDM	Japan	6,715
24	SMIC	Foundry	China	6,322
25	WD/SanDisk	IDM	U.S.	5,905

Source: Techinsights

Semiconductor companies are categorized into IDMs, fabless, foundries, and others depending on the scope of their manufacturing processes and specialized business domains. The following section explains each company type,

including the major players (excluding major Korean companies, which will be discussed later) and their business trends.

(1) IDM

An IDM is a type of company that handles every stage of the process—from design to front-end and back-end manufacturing, and distribution and sales. Major Korean companies such as Samsung Electronics and SK Hynix are classified as IDMs, as are U.S. semiconductor companies such as Intel and Micron.

Intel, the top IDM by semiconductor sales, was founded in the U.S. in 1968 to design, manufacture, and sell computer components and related products. As of 2023, it recorded semiconductor sales of 51.5 billion USD, ranking second among global semiconductor companies. Its main products include CPUs, microprocessors, chipsets, and flash memory. Among these, sales of PC CPUs alone accounted for 54.9% of its total in the third quarter of 2024, making Intel a company with a strong presence in system semiconductors.

Intel holds the world's largest share—over 70%—in the CPU market for personal computers (PCs) and servers. Ahead of the transition to the AI-PC era, which began in earnest in 2024, this company has strengthened its next-generation "Core Ultra" processors—designed for AI computing and high-performance processing—and announced plans to produce 100 million CPUs for AI PCs by 2025. Intel's Core Ultra processors adopt a tile-based CPU architecture to improve both performance and power efficiency in PCs. They are equipped with "AI Boost," an NPU specialized for AI processing, and the "Intel Arc" Graphics Processing Unit (GPU). By supplying this series to a variety of PC manufacturers, Intel aims to take the lead in the coming AI PC era. To streamline its business portfolio and reduce AI-PC launch costs, Intel has announced that it will terminate approximately 15,000 of its 131,000 employees by the end of 2024, while lowering R&D and general marketing expenditures from 20 billion USD in 2024 to 17.5 billion USD in 2025.

Micron is an IDM company that was founded in the U.S. in 1978; it develops, manufactures and sells memory semiconductors that are highly regarded worldwide for their technological excellence. As of 2023, it recorded semiconductor sales of 16.7 billion USD, ranking 11th among global semiconductor companies. Its main products are memory semiconductors, including Dynamic Random Access Memory (DRAM), NOT AND (NAND) flash, and Enterprise Solid State Drive (eSSD). In the case of DRAM, Micron posted sales of 4.5 billion USD in the second quarter of 2024, ranking third in global market share after Samsung Electronics and SK Hynix.

Micron is also advancing the development of HBM technology to meet demand in next-generation technology fields. In 2024, it developed an 8-layer High Bandwidth Memory version 3 Extended (HBM3E) product and supplied it to NVIDIA; in the same year, it successfully created a 12-layer HBM3E. By 2025, it aims to mass-produce a 16-layer HBM3E, which will be faster than other products, thereby challenging Samsung Electronics' dominance of memory semiconductor sales. While Micron has long been considered weaker than Samsung Electronics and SK Hynix in HBM production capacity, it announced groundbreaking for an HBM plant in Singapore in 2025; this plant is scheduled for completion in 2027 and is expected to strengthen Micron's production capacity. Additionally, to secure outstanding talent in the field of memory semiconductors, the company is recruiting engineers worldwide. Thanks to these technological development efforts, Micron's HBM products are said to be more competitive in both price and performance than Samsung Electronics' products, which have faced heat-related issues. As a result, Micron's influence in the HBM market is expected to grow significantly in the coming years.

(2) Fabless

A fabless company specializes in the design field, outsourcing manufacturing to foundries based on the semiconductor intellectual property (IP) it develops and secures. NVIDIA, which ranked first among semiconductor companies by market capitalization in 2023 and recorded semiconductor sales of 49.6 billion USD—placing it fourth in the global semiconductor sales ranking—falls into this category. Founded in the U.S. in 1993, NVIDIA is a fabless company that designs and supplies GPUs, mobile computing chips and automotive semiconductor chips. Its core products are GPUs and AI semiconductor chips, and it currently holds approximately 90% of the global GPU market and about 80% of the global AI semiconductor chip market.

GPUs are system semiconductors that are capable of processing multiple data streams in parallel; they are specialized for fields that handle large-scale data. Traditionally, GPUs have been mainly used for applications such as visualizing game graphics, but more recently, their use has expanded to accelerating workloads in high-performance AI computers, including data centers and autonomous vehicles. With the advancement of AI technologies, demand for NVIDIA's GPUs is expected to increase even further.

Currently, the AI semiconductor chip market is virtually monopolized by NVIDIA, and securing supply contracts with the company has become the key factor for HBM manufacturers to lead the market. SK Hynix and Micron have delivered HBM to NVIDIA, whereas Samsung Electronics continues to seek contracts for its products.

Meanwhile, NVIDIA plans to establish a large-scale R&D center in Taiwan to strengthen its collaboration with TSMC, the world's largest foundry. Currently, NVIDIA outsources the production of AI accelerators[2]—comprising GPUs and HBM—to TSMC. To establish this center, NVIDIA has requested a 30,000-square-meter site from the Taiwanese authorities, and approximately 24.3 billion New Taiwan dollars are expected to be invested in the facility's construction.

(3) Foundry

A foundry company is entrusted by design companies to manufacture their products; it is responsible for the actual production process. Currently, Taiwan's TSMC, which ranks first among global semiconductor companies in sales, is the most representative example of the foundry type. Established in 1987, TSMC now produces system semiconductor chips for major fabless companies such as NVIDIA, Qualcomm and Apple. As of 2023, TSMC held approximately 62% of the global foundry market share, a figure far higher than Samsung Electronics' 12% share, which ranked second.

Behind TSMC's success lie several key factors: a business structure that does not compete with its client design companies, the windfall benefits arising from U.S.-China trade frictions[3], strong support from the Taiwanese government, and continuous efforts to secure talent. TSMC's founder, Morris Chang, has emphasized that the Taiwanese government's support for creating an environment where outstanding talent could be steadily nurtured was a primary factor in the company's success. A representative example is Hsinchu Science Park, where TSMC's headquarters are located and which serves as a hub for semiconductor talent development. Established in 1980 by the Taiwanese government to foster the electronics industry, the park hosts National Tsing Hua University—one

2 Hardware used to accelerate AI information processing.

3 Due to the rise in tariff rates on Chinese companies resulting from the U.S.-China trade friction, transactions between the United States and Taiwan in the semiconductor sector have increased.

of Taiwan's top four universities—along with National Yang Ming Chiao Tung University, government-affiliated research institutes, and research centers of major electronics companies. To promote the vitality of Hsinchu Science Park, the Taiwanese government implemented supportive policies, including partial exemptions from tariffs and corporate taxes for companies, as well as tax credits for educational expenses. Under this government support, leading companies and academic institutions in Taiwan's electronics industry have gathered at the park, actively engaging in industry-academia-research collaboration. For example, corporate researchers and executives lecture at universities, whereas graduate students are employed as research assistants in laboratories. Furthermore, research institutes focus on the commercialization of technology, producing results through the intensive development of commercially viable innovations.

In the fourth quarter of 2024, 75% of TSMC's total sales came from transactions with U.S. companies. Against this backdrop, massive subsidies for the establishment of semiconductor plants in the U.S. under the U.S. CHIPS and Science Act have encouraged TSMC to build an advanced semiconductor manufacturing plant in Arizona, which is scheduled to begin full-scale operations in 2025. The U.S. plant will mass-produce advanced 3–4 nanometer (nm) chips for major American clients such as NVIDIA and Apple. Moreover, TSMC has announced plans to introduce 2 nm chip production technology—the current state-of-the-art process—into its U.S. plant by 2028. However, these projections for the introduction timeline could be accelerated owing to the Trump administration's emphasis on its "America First" policy. While the operation of the U.S. plant may strengthen TSMC's relationships with its American customers, a major challenge will be securing sufficient production personnel locally.

1.2 Background and Characteristics of the Development of the Korean Semiconductor Industry

1.2.1 Background of the Development of the Korean Semiconductor Industry

The Korean semiconductor industry has developed mainly around memory semiconductors. The history of the Korean semiconductor industry can be divided into two stages: the introduction and development period, both centered on memory semiconductors. Owing to South Korea's low wages in the mid-1960s, U.S. companies introduced semiconductor technology by transferring labor-intensive semiconductor assembly and packaging technologies. Subsequently, in 1974, South Korea Semiconductor was established as the first Korean company engaged in wafer processing and chip production, jointly funded by a South Korean firm and a U.S. local subsidiary. In 1977, South Korea Semiconductor was merged into the Samsung Group[4], marking the beginning of the full-scale development of the Korean semiconductor industry.

In its early years, the Korean semiconductor industry pursued technology development and research under government leadership. In 1981, the Ministry of Trade and Industry[5] formulated the "Detailed Plan for the Promotion of the Semiconductor Industry," a policy to support the industry. This policy implemented measures to advance production structures, establish a framework for technology development and secure highly skilled human resources.

4 In December 1974, Samsung acquired a 50% stake in "Korea Semiconductor," and by obtaining the remaining shares in 1977, it made the company a wholly owned subsidiary.

5 Corresponds to the present Ministry of Trade, Industry and Energy.

In 1986, the government launched the "Collaborative Development Project for Ultra-High Integration Semiconductor Technology," promoting joint R&D of fundamental technologies for DRAM and other products by private companies (such as Samsung Electronics, Goldstar Semiconductor (now LG) and Hyundai Electronics) together with the Semiconductor Research Institute, which was affiliated with Seoul National University. Such government support enabled large enterprises to lay the foundation for the development of memory semiconductor technologies, which had relatively low entry barriers in the early stages, and to establish semiconductor production systems.

In 1992, Samsung Electronics succeeded in developing the world's first 64M DRAM, marking the beginning of the full-scale development of the Korean semiconductor industry, centered on memory semiconductors. Compared to system semiconductors, memory semiconductors require less design complexity and have lower entry barriers, but they demand large-scale initial investments to establish mass-production facilities. Korean companies made significant investments to secure technological leadership in memory semiconductors, driving both technological advancement and production expansion. Between 1987 and 1992, Samsung Electronics' capital expenditures-to-sales ratio in its semiconductor division was 39.8%, nearly double the global average of 20.5% at the time. During the 1990s, the rapid growth of the digital device market caused demand for memory semiconductors to surge, creating a favorable environment for Korean memory-focused semiconductor companies to establish themselves as global players. In the late 2000s, Korean companies that had secured technological leadership adopted a "golden price strategy[6]," which led to oversupply in the semiconductor market. Consequently, semiconductor prices fell worldwide, and memory manufacturers outside South Korea faced a wave of bankruptcies. In this way, Korean IDMs such as Samsung Electronics and SK Hynix ultimately prevailed in the memory semiconductor "game of chicken." Today, the global memory semiconductor market is dominated by a three-company structure led by these two firms along with Micron.

Thus, South Korea secured a strong position in the global semiconductor market through a strategy focused on memory semiconductors. More recently, as the importance of system semiconductors has increased with advances in IT and the expansion of AI, the Korean government has been actively promoting support policies to develop the system semiconductor industry. To broaden the base of the system semiconductor sector, South Korea implemented the "System IC 2010" project from 1998 to 2011, and the "System IC 2015" project from 2011 to 2016. As a result, South Korea achieved global competitiveness in certain areas such as Large Display Driver ICs (LDI) and CMOS Image Sensors (CIS)[7]. However, South Korea lacks sufficient competitiveness in system semiconductor markets for advanced industries such as AI and autonomous vehicles.

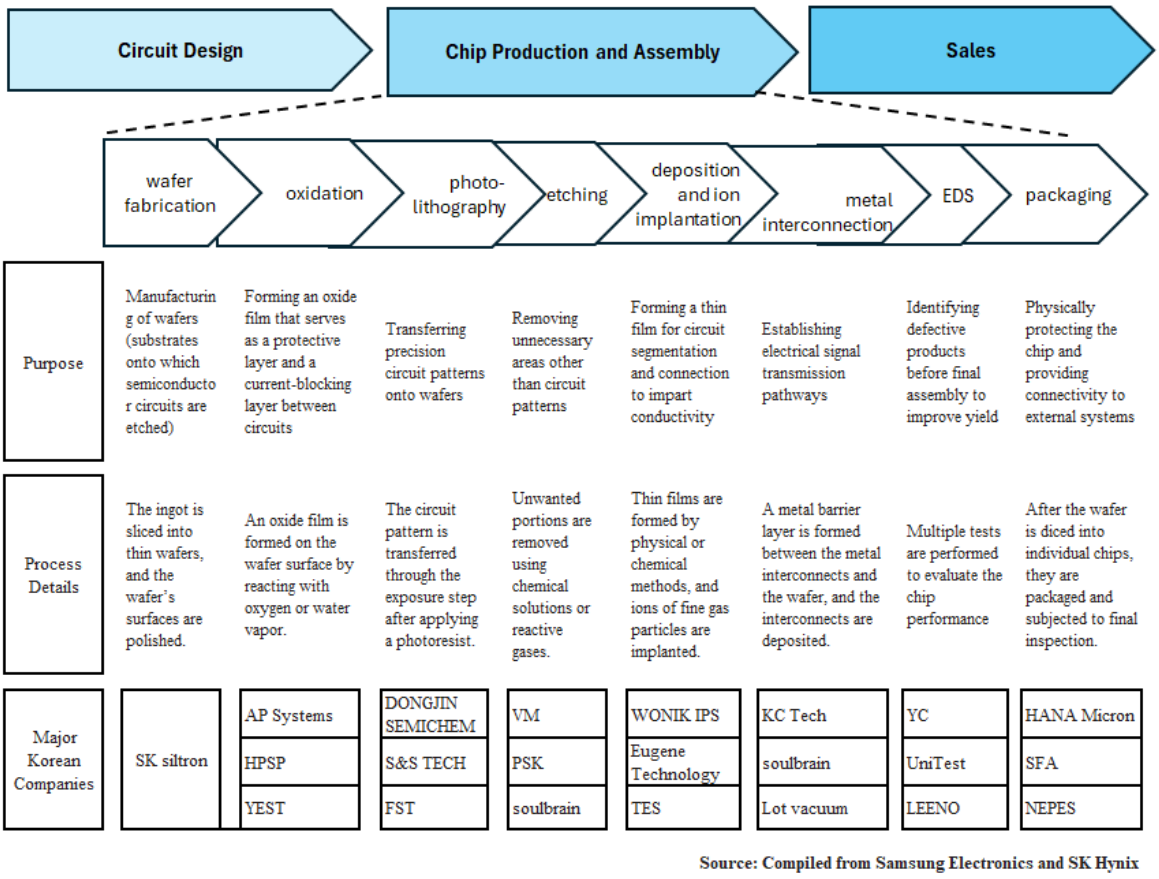
1.2.2 Classification of Manufacturing Processes in the Korean Semiconductor Industry

As shown in Figure 1-2, the semiconductor industry value chain can be divided into three stages: circuit design, semiconductor chip production and assembly, and sales. In practice, manufacturing semiconductors involves several hundred complex processes. However, in the Korean semiconductor industry, a total of eight processes—from wafer

6 A strategy in which companies with highly cost competitiveness defeat competitors through pricing policies.

7 Fields such as LCD driver chips and CMOS image sensors.

fabrication, which falls broadly under the production stage, to packaging, which is part of the assembly stage—are classified as major semiconductor manufacturing processes.



Source: Compiled from Samsung Electronics and SK Hynix

Figure 1-2 Value Chain and Major Manufacturing Processes in the Semiconductor Industry

The semiconductor manufacturing process begins with wafer fabrication. In this process, a substrate—on which semiconductor chips will be built—is manufactured. A cylindrical crystal, called an ingot, is produced by growing high-purity silicon melt into a solid crystal. The ingot is then sliced into thin, uniform wafers and its surface is polished, yielding a completed wafer.

Next is the oxidation process: oxygen reacts with the silicon wafer's surface to form an oxide film. Depending on the type of gas used, different oxidation methods, such as wet oxidation and dry oxidation, are employed. The oxide film blocks leakage currents between circuits and enhances precision in later processes, such as ion implantation and etching.

In the photolithography process, the semiconductor circuit patterns—completed during the parallel design stage—are transferred onto the wafer. Here, a photosensitive liquid (photoresist) that changes its chemical properties when exposed to light, such as ultraviolet rays, is evenly coated onto the wafer's surface. Then, in the exposure step, light is passed through a photomask containing the circuit pattern to transfer it onto the wafer, creating chemical differences between the patterned and unpatterned regions. Finally, a developer solution is applied to selectively remove parts of the photoresist, thereby forming the circuit pattern.

The fourth process involves etching. This process removes unwanted portions outside the circuit patterns that were

formed during photolithography and is considered one of the most critical steps in semiconductor manufacturing. Etching comprises two methods: dry etching, which uses reactive gases, and wet etching, which uses chemical solutions. Wet etching is faster and relatively simpler, but less precise. Therefore, dry etching is typically used for manufacturing the core layers of semiconductors. In this process, a dry etching technique that utilizes plasma-state gases is widely used in the field because it can selectively remove specific materials and achieve highly precise micro-circuit patterns.

The deposition and ion implantation processes involve covering the etched wafer with ultra-thin atomic-scale films through physical or chemical deposition, and uniformly implanting ionized particles into the wafer, respectively. The thin films formed by deposition serve as insulating layers that prevent current leakage and contamination, or as conductive layers that transmit electrical signals between circuits. In the ion implantation process, impurities (ions) are implanted into the otherwise insulating silicon wafer to give it electrical conductivity, enabling current to flow.

Metal interconnection, the sixth process, connects external power sources to individual devices or to multiple devices, using metal wiring to transmit electrical signals. Metals such as aluminum and copper are commonly used for wiring. However, as these metals tend to react with silicon, the primary material of wafers, it is vital to form a barrier layer (barrier metal) using substances such as titanium. The metal interconnection process is also carried out through deposition, employing highly uniform chemical methods.

The Electrical Die Sorting (EDS) process is conducted before the final assembly stage (the packaging process) and involves multiple inspections of the semiconductor chips to test their performance, identify defective products, repair defective chips and correct issues in the process or design stages; the goal of this process is to improve yield[8]. The performance tests include several stages: first, determining the electrical performance of individual devices and whether they can operate normally under specific environments, such as temperatures that are higher or lower than room temperature. Then, chips deemed repairable are repaired, and a final test verifies whether the repair was properly executed. Lastly, to ensure no defective products are included in the assembly, defective chips are marked with special ink for easy identification.

Among the processes described above, six (excluding wafer fabrication) constitute the stages of semiconductor chip production carried out on the wafer and are referred to as the "front-end process." The subsequent step, in which the fabricated semiconductors are separated into individual chips and assembled, is called the "back-end process," and includes packaging. Chips determined to be non-defective through the EDS process are cut into individual chip units and connected to lead frames and Printed Circuit Board (PCB) substrates—board-shaped components that mount electronic parts and electrically interconnect them—so that the semiconductors can be electrically connected to external boards and electronic devices. Finally, the chips are protected against heat and moisture, and, if necessary, packaged in specific forms and subjected to various tests, such as electrostatic discharge and physical durability tests.

1.2.3 Current Status of Major Semiconductor Companies in South Korea

As noted above, the Korean semiconductor industry structure has been formed mainly around major IDMs such as

[8] It refers to production efficiency, defined as the number of functional chips actually produced relative to the maximum number of chips designed per wafer.

Samsung Electronics and SK Hynix. However, in addition to these two leading IDMs, there are companies engaged in fabless (e.g., LX Semicon) and foundry businesses (e.g., DB HiTek). Moreover, both Samsung Electronics and SK Hynix operate foundry businesses through their own divisions (Samsung Electronics Foundry Business Division) or subsidiaries (SK Keyfoundry).

Table 1-2 presents a list of major Korean companies by semiconductor business type, along with relevant information on each company. The sections following Table 1-2 provide an overview of each company's business and recent developments.

Table 1-2 Major Semiconductor Companies by Type in South Korea (Unit: KRW)[9]

Type	Company	Semiconductor Division Sales		Notes
		2023	2024	
IDM	Samsung Electronics	66 trillion 594.5 billion	111 trillion 66 billion	Composed of Memory, System LSI and Foundry Divisions
	SK Hynix	32 trillion 765.7 billion	66 trillion 193 billion	Currently developing foundry and fabless businesses
	On Semicon Korea	1 trillion 106 billion	1 trillion 381.8 billion	Korean subsidiary of OnSemi (U.S.)
Fabless	LX Semicon	1 trillion 898.8 billion	1 trillion 865.6 billion	Ranked within the top 50 global fabless companies
	ABOV Semiconductor	232.4 billion	232.1 billion	
	Telechips	191.1 billion	186.6 billion	
Foundry	DB HiTek	1 trillion 154.2 billion	1 trillion 131 billion	
	SK Keyfoundry	522.1 billion	540.9 billion	Subsidiary of SK Hynix
OSAT (Outsourced Semiconductor Assembly and Test)	HANA Micron	967.9 billion	1 trillion 250.7 billion	
	SFA Semicon	437.6 billion	400.5 billion	Subsidiary of SFA
	Doosan Tesna	338.7 billion	363.7 billion	Subsidiary of Doosan
Manufacturing equipment	SEMES	2 trillion 502.1 billion	2 trillion 432.7 billion	Subsidiary of Samsung Electronics, equipment for semiconductor front-end and back-end processes
	SFA	1 trillion 17.9 billion	971.3 billion	Partner company of Samsung Electronics; provides equipment for semiconductor front-end and back-end processes
	WONIK IPS	690.3 billion	748.2 billion	Partner company of Samsung Electronics; provides equipment for the process of generating circuits on wafers

Source: Compiled from the business reports of each company.

(1) Samsung Electronics (IDM)

Samsung Electronics was established in 1969; it is a comprehensive electronics company engaged in the design, manufacture, and sales of semiconductors, electronic products, displays, telecommunications equipment, and various electronic components. Its business divisions consist of the Device eXperience (DX), Device Solutions (DS), Samsung Display Corporation (SDC), and Harman. The IDM business is handled by DS. Within DS, semiconductor products and processes are further divided into three business units: the Memory Business Unit, System LSI Business Unit and Foundry Business Unit[10]. In 2023, DS recorded sales of approximately KRW 66.5945 trillion. Memory semiconductors accounted for about KRW 44 trillion of DS' sales, representing approximately 66% of the division's total sales.

Samsung Electronics' main products include memory semiconductors such as DRAM and solid-state drives (SSD),

[9] Samsung Electronics' Foundry Business Division and SK KeyFoundry, although belonging respectively to Samsung Electronics and being a subsidiary of SK Hynix, are operated independently from their IDM divisions and are therefore listed separately.

[10] The Memory Business Division, which manufactures memory semiconductors, constitutes the memory semiconductor IDM business; the System LSI Business Division is responsible for IDM operations in semiconductors other than memory; and the Foundry Business Division is exclusively in charge of manufacturing semiconductors designed by fabless companies.

and system semiconductors such as display driver IC chips (DDIs). Recently, in May 2024, the company established a dedicated HBM division to expand its next-generation memory business. On account of its foundry business's sluggish performance, investment in foundry facilities has recently declined. Redeployment of top talent into the memory business, where the company has been focusing resources, is under consideration; the company is also evaluating the creation of a collaborative structure between memory and foundry researchers at Samsung's Semiconductor Research Institute. The stagnation of Samsung Electronics' foundry business is the outcome of a combination of internal and external factors. Among external factors, a global economic downturn has reduced demand in the mobile market, leading to fewer orders. Internally, Samsung has failed to achieve the technological innovations needed to respond to TSMC's dominance in advanced semiconductor fields and the catch-up efforts of Chinese firms in legacy semiconductor segments, resulting in challenges in securing major clients. To regain leadership in the memory semiconductor sector, Samsung needs to establish technological competitiveness over rival SK Hynix. Currently, SK Hynix supplies NVIDIA with 5th-generation HBM3E. In contrast, Samsung has only been able to supply 4th-generation HBM3E after failing quality tests. To overcome this situation, Samsung announced its plan to mass-produce 6th-generation HBM4 in the first half of 2025, thereby regaining leadership in the advanced memory semiconductor race. To this end, the company has been significantly expanding its workforce, adding personnel with experience in back-end process technology development for memory semiconductors.

(2) SK Hynix (IDM)

SK Hynix was originally founded as Hyundai Electronics and acquired by the SK Group in 2012. It designs and manufactures semiconductors. Like Samsung Electronics, it is proficient in manufacturing memory semiconductors; some of its main products include DRAM, NAND flash, and multi-chip packages (MCPs). In 2024, the company recorded sales of KRW 66.193 trillion and an operating profit of KRW 23.467 trillion, marking the highest performance since its establishment.

SK Hynix has achieved strong results, driven by increased sales of HBM and eSSD. As of 2024, this company is the exclusive supplier of 5th-generation HBM (HBM3E) to NVIDIA, and its HBM market share has reached 53%. Furthermore, it aims to launch 6th-generation HBM by the second half of 2025, which is expected to improve training performance by 18% and inference performance by 32% compared to the previous generations. To lead the next-generation memory semiconductor market, SK Hynix established a new "HBM Business" division in early 2024, consolidating all HBM-related functions across the company. This division encompasses Product Engineering (PE), Application Engineering (AE), and Project Management (PM) teams, all aimed at advancing HBM development, production, and distribution. In line with this goal, the company has been actively recruiting highly skilled personnel for HBM-related operations, hiring more than 1,000 employees in 2024 alone through seven rounds of recruitment. In addition to domestic efforts, SK Hynix also plans to establish a packaging production base in the U.S. state of Indiana to secure top global talent.

(3) LX Semicon (fabless)

Established in 1999, LX Semicon is a fabless company specializing in semiconductor design; it operates with a single business division focused on system integrated circuits (ICs). The company designs key components, such as DDIs that drive display panels and timing controllers(T-Cons). Production is outsourced to foundries and Outsourced Semiconductor Assembly and Test (OSAT) companies, and the finished products are sold thereafter. Among Korean

fabless companies, LX Semicon is the only one with annual sales exceeding KRW 1 trillion. In 2024, it recorded sales of KRW 1.8656 trillion and an operating profit of KRW 167.1 billion.

This company is competent in the manufacture of DDI products. However, as of 2024, 92% of its total sales depend on DDIs, which could prove to be a weakness owing to business fluctuations in the downstream display industry. To address this challenge, the company has been pursuing business diversification, including the development and sales of new businesses, such as Microcontroller Units (MCUs), power management semiconductors based on new materials[11] and heat dissipation substrates. In 2021, a dedicated division for the development of power management semiconductors was established, and the company has been actively recruiting personnel with master's and doctoral degrees. In 2022, it built a 9,900-square-meter plant for the production of heat dissipation substrates in Siheung, Gyeonggi Province, South Korea. Thus, LX Semicon expects growing demand for IC design personnel in fabless operations and for technical staff to manage production processes.

(4) HANA Micron (OSAT)

HANA Micron was established in 2001 and is a company specializing in semiconductor back-end processes. It provides packaging and testing services for memory and system semiconductors to IDM companies such as Samsung Electronics and SK Hynix. Through subsidiaries, such as Hana Materials, it also manufactures and sells components used in semiconductor etching processes. In 2023, the company recorded sales of approximately KRW 968 billion and an operating profit of KRW 57.9 billion, with 66% of its revenue generated from back-end processes.

Currently, HANA Micron is the leading Korean OSAT company, but it has faced challenges in securing overseas customers. As the Korean semiconductor industry is centered on memory semiconductors, expanding into overseas markets by strengthening its presence in system semiconductors has become a key challenge. To this end, HANA Micron has been developing advanced AI semiconductor technologies, such as 2.5D packaging technology[12], while hiring local talent at its overseas subsidiaries in the U.S. and Vietnam to strengthen its global footprint. Additionally, it has established a "System Semiconductor Test Support Center" in Pangyo, Gyeonggi Province, South Korea, where chips developed by fabless firms can be verified at low cost, thereby supporting the independence and growth of domestic fabless companies.

(5) SEMES (semiconductor equipment)

SEMES, a subsidiary of Samsung Electronics, was established in 1993 and is a company that manufactures and sells semiconductor and display-related equipment. This company produces products used throughout the semiconductor production process—from front-end etching equipment to back-end wafer probers. In 2023, it recorded sales of approximately KRW 2.5 trillion, of which 62% originated from semiconductor manufacturing equipment.

SEMES has independently developed products such as chemical pumps used in cleaning processes, and NAND flash etching equipment, thereby reducing supply risks in semiconductor manufacturing equipment for the Korean semiconductor industry. However, some critical components used in its equipment still have significant technological gaps compared to those of major overseas equipment manufacturers. To address this issue, the company plans to

[11] A semiconductor with the function of supplying power to electronic devices.

[12] An advanced technology that horizontally arranges and interconnects system semiconductors and memory semiconductors such as HBM.

update its technology, particularly in areas with high dependence on foreign suppliers. This will involve building an R&D center in Yongin, Gyeonggi Province, South Korea—where the semiconductor cluster is located—and recruiting highly skilled personnel with expertise in equipment and component technologies.

1.3 Position of the Semiconductor Industry and Future Prospects in South Korea

1.3.1 Growth Drivers and Risk Factors of Memory and Non-Memory Semiconductors

As described in Section 1.2.2, the Korean semiconductor industry is led by its two major IDMs, Samsung Electronics and SK Hynix. Other firms—including fabless companies—are composed of small- and medium-sized enterprises whose annual sales do not exceed KRW 1 trillion. In particular, the presence of fabless companies—that design system semiconductors—and foundry companies—that handle production—remains weak, making the system semiconductor sector less competitive than their counterparts in memory semiconductor production. Furthermore, in the back-end process, as well as in the materials, components and equipment sectors, weak business relationships and limited transactions with overseas companies have been identified as factors contributing to low international competitiveness. In the following sections, the growth drivers and risk factors for the future of Korean semiconductor industry will be discussed separately for memory and non-memory semiconductors.

(1) Growth Drivers for Memory Semiconductors: AI Industry

As seen in Section 1.1.1, while the global semiconductor market has shown volatile growth, such as experiencing temporary negative growth in 2023, the AI semiconductor market has steadily expanded based on AI industry growth and is expected to serve as a key driver of future semiconductor market growth. Since AI technology requires learning and rapidly processing massive volumes of data, semiconductors with higher performance and efficiency than conventional semiconductors are in demand. Accordingly, in the field of system semiconductors, NPUs and SoCs that perform learning, inference, and computation for AI big data are being developed, whereas in the field of memory semiconductors, products such as HBM, which enable the rapid processing and storage of massive data, are being advanced.

Goldman Sachs, a global investment bank, projects that the HBM market will grow from USD 2.3 billion in 2023 to USD 30.2 billion in 2026, with three companies—Samsung Electronics and SK Hynix of South Korea, and Micron of the U.S.—expected to lead the market. In August 2023, SK Hynix became the first company to develop 5th generation HBM (HBM3E). It subsequently followed this success by becoming the first company to supply HBM3E to NVIDIA. SK Hynix is expected to maintain a market share of over 50% in this segment through 2026. Since 2024, SK Hynix, Samsung Electronics, and Micron have begun mass-producing this technology. At present, the technological gap among the three companies is insignificant, and securing customer companies through the rapid development of next-generation technologies is expected to be the key to gaining future market share. Furthermore, demand is expected to grow not only from NVIDIA, the primary HBM customer today, but also from major big tech companies such as Google and Amazon. As a result, product development and mass-production capabilities that can respond appropriately to diverse demand will become increasingly important. Currently, Korean companies account for more than 60% of

the global memory semiconductor market, and with demand for related products, such as HBM, expected to rise, the small technological gap among leading firms means that securing advanced technological capabilities and customer companies will likely drive the rapid growth of the memory semiconductor industry, fueled by advances in AI.

(2) Risk Factors for Memory Semiconductor Growth: Rise of Chinese Companies

As shown in Table 1-3, as of the first quarter of 2025, Samsung Electronics holds a 35.4% share of the global DRAM market by company, whereas SK Hynix accounts for 27.4%. In addition, as illustrated in Figure 1-3, South Korea is estimated to account for 62.8% of global DRAM production capacity, indicating that Korean companies dominate the DRAM market.

Table 1-3 Monthly DRAM Production Capacity and Market Share by Global DRAM Manufacturer[13]
(Unit: thousand wafers, %)

Ranking	Company	Country	2019 (4Q)		2025 (1Q)	
			Production Capacity	Market Share	Production Capacity	Market Share
1	Samsung	South Korea	470	35.9	645	35.4
2	SK Hynix	South Korea	340	26	500	27.4
3	Micron	U.S.	345	26.4	320	17.6
4	Nanya	Taiwan	70	5.3	53	2.9
5	Winbond	Taiwan	27	2.1	23	1.3
6	PSMC	Taiwan	45	3.4	39	2.1
7	JHICC	China	2	0.2	12	0.7
8	CXMT	China	10	0.8	230	9.4
Total			1309	100	1822	100

Source: TrendForce

[13] Announced on a quarterly basis.

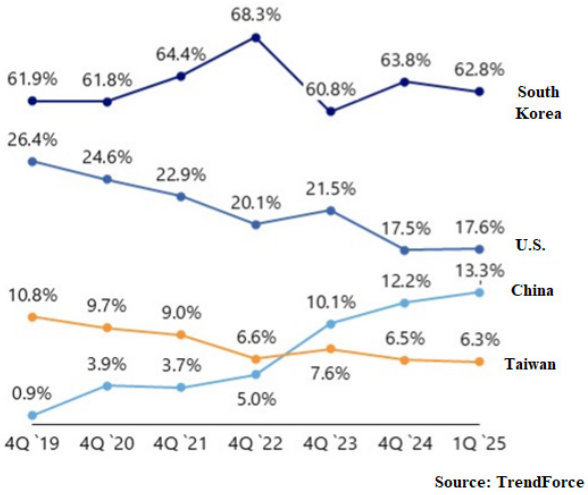


Figure 1-3 DRAM Production Capacity Share by Country (Unit: %)[14]

Chinese memory semiconductor companies are focusing on developing legacy memory semiconductors, which can be manufactured using existing technologies, without the need for cutting-edge processes. While Korean companies are concentrating on advanced semiconductors such as next-generation DRAM and 5th-generation HBM3E, Chinese companies are increasing production of low-power DRAM used in low-spec smartphones, PCs and automotive semiconductors.

Currently, the Chinese companies emerging in the legacy memory semiconductor sector are ChangXin Memory Technologies (CXMT) and Yangtze Memory Technologies Corporation (YMTC). CXMT was established in 2016 and is one of China's leading memory semiconductor manufacturers. Its DRAM market share is expected to expand from approximately 10% in 2024 to 15% in 2025[15]. At present, its main products are mature-process devices, such as 17nm and 18nm DDR4 and LPDDR4; however the company is also actively developing advanced-process products, such as 12nm DDR5, LPDDR5X, and HBM. Based on this information, the technology gap with Korean companies is estimated to be around 2–3 years for 17nm and 18nm processes, and about 1–2 years for 12nm processes.

Around 70–80% of CXMT's products are consumed by the Chinese domestic market, with major customers comprising mid- to low-priced smartphone manufacturers such as Xiaomi and Transsion. Thus, Chinese memory semiconductor companies have been increasing their market share mainly through domestic low-cost home appliance manufacturers, while strengthening their production capacity with government subsidies. Since 2014, the Chinese government has pursued self-sufficiency in the semiconductor supply chain by establishing the "National Integrated Circuit Industry Investment Fund (Big Fund)," which invests in companies across the semiconductor supply chain[16]. Consequently, industry estimates suggest that CXMT's DRAM production capacity increased from 40,000 wafers per

[14] By country, the figures were calculated as follows: for Korea, the combined totals of Samsung Electronics and SK Hynix; for the United States, Micron Group; for Taiwan, the combined totals of Nanya, PSMC, and Winbond; and for China, the combined totals of JHICC and CXMT.

[15] The memory semiconductor market share data from TrendForce cited above is statistical material that excludes CXMT. In contrast, the CEO of SIMO-US, a Taiwanese memory semiconductor manufacturer, predicted that CXMT would steadily expand its sales based on the domestic market and increase its presence in the global market.

[16] The National Integrated Circuit Industry Investment Fund launched its first phase in 2014 and its second phase in 2018, investing more than USD 8.4 billion in over 40 semiconductor companies by the end of 2023. The third phase, launched in 2024, is expected to involve investments of at least USD 27 billion.

month in 2020 to 200,000 wafers per month in 2024. In addition to increasing production, the prices of legacy memory have continued to decline (Figure 1-4).

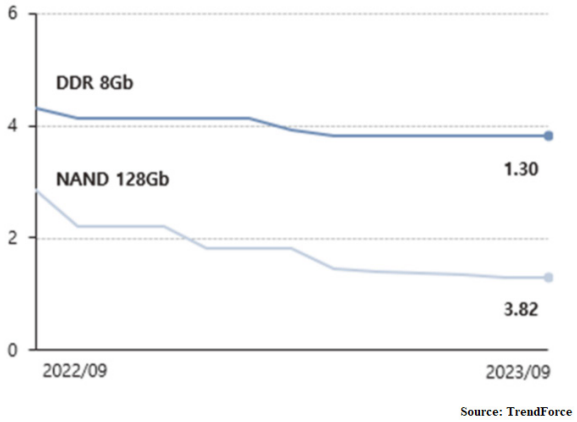


Figure 1-4 Price Trend for DDR 8Gb and NAND 128Gb (Unit: USD)

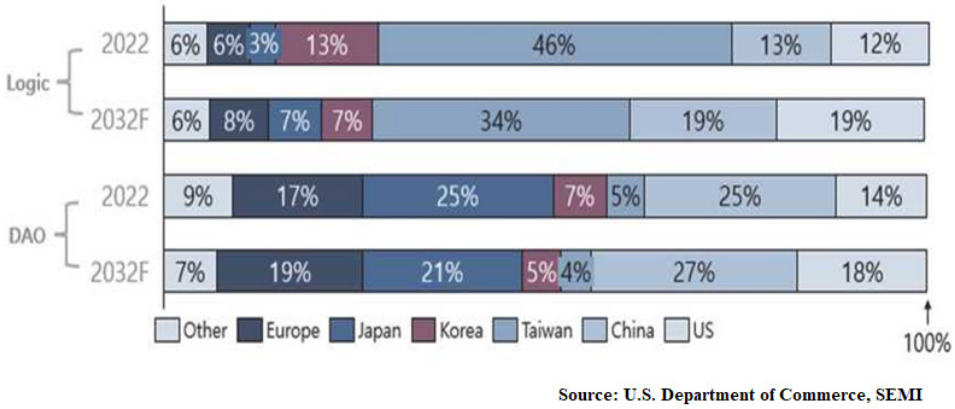
Korean companies suffered financial setbacks owing to Chinese companies' expansion of legacy memory production and the resulting decline in product prices. In 2023, Samsung Electronics' DS division recorded sales of KRW 66.59 trillion, representing a 32% decrease from KRW 98.46 trillion in the previous year. Furthermore, its operating profit fell by 38.7% year-on-year, resulting in a loss of KRW 14.88 trillion. Even SK Hynix incurred an operating loss of KRW 7.73 trillion in 2023; however, on account of increased sales of its flagship HBM3E products, the company recorded an operating profit of KRW 23.47 trillion in 2024, the highest in its history. This contrast highlights the difference with Samsung Electronics, as SK Hynix was able to offset the sluggish performance in its legacy memory business with strong results in advanced semiconductors.

As observed in SK Hynix's turnaround to profitability in 2024, Korean memory semiconductor companies need to strengthen their competitiveness through products utilizing advanced technologies such as HBM to challenge China's production expansion and downward price pressures. In fact, in 2024, SK Hynix announced that it would reduce the share of legacy DRAM production to 20% by the end of the year, and in October 2024, Samsung Electronics also announced a policy to cut production of certain general-purpose products. However, Chinese companies have been expanding their market share in memory semiconductors based on government-led support measures. In contrast, Korean companies have been unsuccessful in their efforts to secure sufficient technological superiority in advanced processes. Based on this reason, criticism has emerged within the industry that, without proactive government support, corporate technological development and strategic efforts, it will be difficult to achieve an overwhelming technological lead—a so-called "super-gap"—in the memory semiconductor sector.

(3) Risk Factors for Non-Memory Semiconductors: Structural disadvantages and intensifying global competition

The non-memory sector consists of fabless and foundry companies engaged in system semiconductor production, OSAT companies responsible for all back-end semiconductor processes and firms supplying materials, components,

and equipment across every stage of production. As shown in Figure 1-5, Korean logic semiconductor production capacity is expected to decline from 13% in 2022 to 7% in 2032, whereas DAO production capacity is projected to decrease from 7% to 5%[17]. The stagnation of Korean semiconductor production capacity and the outlook for its further weakening can be attributed to the following causes. First, in terms of system semiconductor production, Korean foundry companies are lagging behind TSMC, the leading company; they are also struggling to secure client companies. On the design side, in addition to the fact that semiconductor design itself is a field with high entry barriers that require advanced expertise, the presence of Big Tech firms—with massive capital—and Chinese companies—with abundant talent pools—has been rapidly expanding. In this context, Korean companies are relatively weak in the non-memory sector, making it difficult to strengthen their competitiveness in the future.



Source: U.S. Department of Commerce, SEMI

Figure 1-5 Current Status and Future Outlook of Non-Memory Semiconductor Production Capacity by Country

In terms of securing talent, the shortage of personnel engaged in Korean system semiconductor companies compared with overseas firms is also cited as a major risk factor for the future growth of this sector. According to the "Semiconductor-Related Human Resources Development Plan" that was jointly announced by Korean government ministries in 2022, a single major U.S. fabless company such as Qualcomm employs as many as 20,000 design engineers. In contrast, the total number of design personnel across approximately 200 fabless companies in South Korea amounts to only about 10,000, indicating a severe undersupply of design talent. Another issue is the outflow of skilled personnel overseas. South Korea's Ministry of Trade, Industry and Energy estimated that the damage caused by technology leakage between 2018 and 2022 amounted to approximately KRW 26 trillion, noting that the proportion of semiconductor technology leakage because of talent outflow has been increasing. In response, the Korean government enacted the "Special Act on the Reinforcement and Protection of Competitiveness in National Strategic High-Tech Industries" in 2022, introducing protective measures such as managing personnel transfers in national strategic technology sectors, including semiconductors. Despite these efforts, the ongoing outflow of system

[17] DAO (Discrete, Analog and Other) includes non-memory semiconductors such as discrete semiconductors, analog semiconductors, and optoelectronic devices and sensors, excluding logic semiconductors.

semiconductor talent overseas persists, and concerns remain over the weakening of the industrial base owing to talent shortages.

The concentration of Korean system semiconductor companies in a limited field also demonstrates the fragility of the industry's foundation. Among Korean fabless firms, only LX Semicon has sales exceeding KRW 1 trillion. However, its sales structure is heavily dependent on DDIs, which account for 92% of its revenue. Another fabless company, ABOV Semiconductor, designs logic semiconductors but has a sales scale significantly smaller than that of other semiconductor companies. As a result, fabless small and medium-sized enterprises (SMEs) often struggle to secure foundry partners. To address this issue, since 2022 the Ministry of SMEs and Startups has been hosting the "Fabless Challenge." This event is designed to connect promising fabless firms with domestic foundry companies, as part of broader initiatives to support fabless SMEs.

Conversely, system semiconductors are a multi-product sector, and recently demand for custom semiconductors (ASICs) has been increasing over general-purpose semiconductors. This trend could serve as a positive influence on Korean fabless SMEs that are focusing on specialized semiconductors. Going forward, if Korean firms can develop semiconductors that meet the needs of major downstream industry players and secure distribution channels, they may be able to overcome the limitations of their fragile industrial foundation. However, this will require active government support measures for corporate growth and sufficient human resource development.

1.3.2 Efforts for the Development of the Korean Semiconductor Industry

Since its inception in the 1980s, the Korean government has supported the semiconductor industry's growth through supportive policies and initiatives. In the early stages of industrial development, the government focused on fostering memory semiconductors, which had relatively low entry barriers and offered Korean companies growth opportunities. However, from the late 1990s, it also began promoting support measures aimed at strengthening the system semiconductor sector, such as the "System IC 2010" project. The recent direction of government strategy can be summarized as follows (see Table 1-4):

(1) maintaining competitiveness in memory semiconductors,

(2) strengthening competitiveness in system semiconductors, and

(3) achieving self-sufficiency in materials, components and equipment in preparation for instability in global supply chains.

Table 1-4 Major Government Strategies Related to Korean Semiconductor Industry

Strategy Name (Planning Body and Date of Announcement)	Essential Features	Key Areas
Vision and Strategy for System Semiconductors (Ministry of Trade, Industry and Energy; May 1, 2019)	▶ Support for the full cycle of fabless operations ▶ Building a fabless–foundry collaborative ecosystem ▶ Training specialized human resource ▶ Support for next-generation semiconductor development	Technology R&D Securing Demand Human Resource Development Infrastructure Enhancement

Vision and Strategy for System Semiconductors 2.0 (Joint strategy by various Government Ministries; October 12, 2020)	▶Support for next-generation AI semiconductor development ▶Removing barriers to technology commercialization based on demand ▶Training specialized AI semiconductor personnel ▶Building inter–value chain collaboration ecosystems and strengthening corporate growth infrastructure	Technology R&D Securing Demand Human Resource Development Infrastructure Enhancement
Key Promotion Tasks by Big 3 Industries (Joint strategy by various Government Ministries; November 18, 2021)	▶ Improvement of R&D support systems ▶Strengthening open innovation ▶Establishing a system for securing industrial talent ▶Improving semiconductor research infrastructure	Technology R&D Human Resource Development Infrastructure Enhancement
Measures to Support the Growth of the AI Semiconductor Industry (Ministry of Science and ICT; June 27, 2022)	▶ Securing AI semiconductor technological capabilities ▶Creating initial market demand for AI semiconductors ▶ Building an industry–academia–government collaboration structure for AI semiconductors ▶Training specialized AI semiconductor personnel	Technology R&D Securing Demand Human Resource Development Infrastructure Enhancement
Semiconductor Talent Development Plan (Joint strategy by various Government Ministries; July 2022)	▶Expanding educational institution enrollment capacity through regulatory reform ▶Training semiconductor talent by field and level ▶Building a mid- to long-term support base for semiconductor talent development	Human Resource Development
Strategy to Achieve Semiconductor Superpower Status (Joint strategy by various Government Ministries; July 21, 2022)	▶Comprehensive support for corporate investment ▶Talent development through public–private collaboration ▶Securing leading technologies in system semiconductors ▶Achieving independence in the supply of materials, parts and equipment	Financial Assistance Technology R&D Human Resource Development Infrastructure Enhancement
Plan to Promote the K-Cloud Utilizing Domestic AI Semiconductors (Ministry of Science and ICT; December 12, 2022)	▶ Development of AI semiconductor technologies ▶ Development of software for AI semiconductors ▶Demonstration of data centers and provision of AI services ▶Establishing a promotion system to strengthen industry–academia–government collaboration	Technology R&D Securing Demand Human Resource Development Infrastructure Enhancement
Future Technology Roadmap for Semiconductors (Joint strategy by various Government Ministries; April 2023)	▶Development of new device technologies ▶Securing promising design technologies ▶Development of advanced process technologies ▶Promotion of public–private councils, expansion of investment, review of talent development programs, cultivation of research personnel and promotion of international R&D cooperation	Technology R&D Human Resource Development Infrastructure Enhancement
Plan to Establish a Semiconductor Mega-Cluster (Joint strategy by various Government Ministries; January 15, 2024)	▶Creation of mega-cluster infrastructure and investment environment ▶Full-cycle support to fabless companies for materials, parts and equipment; strengthening of supply chains ▶Securing new semiconductor technologies ▶Training outstanding semiconductor talent and attracting overseas experts	Financial Assistance Technology R&D Human Resource Development Infrastructure Enhancement
AI Semiconductor Initiative (Joint strategy by various Government Ministries; April 25, 2024)	▶ Investment and financial support for the AI semiconductor field ▶Training innovative AI semiconductor talent ▶Establishment of semiconductor research infrastructure ▶Strengthening global cooperation and overseas expansion ▶Leading AI ethics standards	Financial Assistance Technology R&D Securing Demand Human Resource Development Infrastructure Enhancement
Comprehensive Plan to Support and Promote the Semiconductor Ecosystem (Joint strategy by various Government Ministries; June 26, 2024)	▶Financial, tax and fiscal support ▶Construction of power, water and roads within mega-clusters	Financial Assistance Technology R&D Human Resource Development Infrastructure Enhancement

Source: Various policy documents

As one of the key pillars of the semiconductor industry's development, the Korean government has also been focusing on expanding the talent pool. In 2022, it announced the "Semiconductor Talent Cultivation Plan," thereby recognizing workforce development as an independent and major policy priority. Details of this plan and its

implementation framework will be discussed in Chapter 3.

In line with the government's strategic direction, both the education sector and industry are pursuing their own initiatives. As shown in Table 1-5, the education sector provides students with opportunities to acquire semiconductor knowledge through curricula, and supports the implementation of education programs conducted by relevant government agencies under the national talent development plan. Meanwhile, the government is promoting publicly funded, industry–academia joint talent development projects; institutions selected for such projects collaborate with companies to design and implement curricula.

Table 1-5 Major Semiconductor-related Education Systems by Educational Stage

	High School	Associate Degree[18]	Bachelor's Degree	Master's/Doctoral Degree
Education System	Vocational High School–linked Employment-Oriented Training Program	Specialized Leading University for Emerging Industries	Semiconductor Specialization University	Graduate School of Semiconductor Specialization

Alternatively, industry participates in government projects based on public–private cooperation and, together with academia, works to foster external talent; it also advances initiatives to strengthen the capabilities of internal personnel (Table 1-6). Large corporations, which can make large-scale capital investments, are reinforcing their talent base in the following ways. First, externally, they establish contract departments at universities to provide students with practical knowledge and thereby secure outstanding talent. Internally, they operate their own universities that grant degrees accredited by the Ministry of Education. They also offer a variety of job training programs and run educational programs for employees of partner companies, thereby contributing to the government's key strategic goal of achieving self-sufficiency in the semiconductor supply chain. In the case of SMEs, they mainly participate in government-led industry–academia research projects to expand contact with students and strengthen internal capabilities by joining collaborative programs organized by large corporations; they also participate in government-promoted education programs.

Table 1-6 Key Policies for Human Resource Development in Industry

	Large corporations	Mid-sized and small businesses
Talent Acquisition	Operation of Contract Departments: e.g., Department of Semiconductor Systems Engineering at Sungkyunkwan University, which is a contract department of Samsung Electronics.	Participation in Nationally Supported Industry–Academia Collaboration Programs: Contract-based departments for SMEs Cooperative vocational high school recruitment and job training programs
Enhancement of in-house Capability	Operation of in-house Universities (e.g., Samsung Electronics Engineering College)	Participation in Government- and Large-Enterprise-led in-House Workforce Development Projects: Re-education–oriented work–study parallel programs Initiatives such as SK Hynix Hy-Five

[18] An associate degree refers to students who have completed a two- or three-year educational program at a vocational (specialized) college

2 Current Situation of Demand for Human Resources in the Semiconductor Industry and the Issues

As discussed in the previous chapter, since 2020, the semiconductor industry has been continually growing because of innovation and development of downstream cutting-edge industries. Additionally, corporate investment is expanding, particularly in artificial intelligence (AI) and semiconductors, and the market is poised for rapid expansion. However, a significant issue persists: the supply of human resources lags behind industry demand.

According to the Korea Semiconductor Industry Association, demand for human resources by the semiconductor industry was 177,000 personnel in 2021, expected to expand to 304,000 in 2031. However, the current supply is slightly above 5,000 people annually—that is, 50,000 employees over the past 10 years; this cannot meet the growing demand. Thus, the industry may experience acute a human resources shortage in the future.

In this context, the government of Korea has been revising its human resources development policies. However, concerns regarding inadequacy of workforce persist. Furthermore, discrepancies between the quality of desired employees and skill level of available graduates, as well as the lack of comprehensive human resources development considering specific talent required by different technology fields are crucial challenges. This chapter discusses the current situation of demand of human resources in the semiconductor industry and related issues.

2.1 Type and Talent of Human Resources Required by the Semiconductor Industry

Table 2-1 presents the number of employees in the semiconductor industry as of the end of 2022 according to the Korea Employment Information Service. The semiconductor materials has the largest proportion with 46.5%, followed by semiconductor process equipment (28.1%), system semiconductor manufacturing (13.8%), and memory semiconductor manufacturing (11.6%)[19]. The number of employees in semiconductor materials and process equipment is comparatively larger than in other sectors. This is because these sectors mainly comprise SMEs with lower labor productivity and larger workforce as compared to memory semiconductor manufacturers, which mainly comprise large enterprises. According to the survey on the actual situation of employment transition of semiconductor manufacturing industry announced by the Korea Employment Information Service, 54.3% of the employees of memory manufacturing belong to large enterprises with 300 or more employees. Meanwhile, 61.9% and 70.7% of the employees of the semiconductor process equipment and semiconductor materials, respectively, belong to SMEs with less than 300 employees.

[19] These four sectors are classified based on the semiconductor-related products to develop or manufacture. The Employees are employees working on development and production in each sector: the Semiconductor Materials, parts and materials including semiconductor wafers; the Process Equipment, semiconductor manufacturing equipment; the System Semiconductors, system semiconductors including IC chips; and the Memory Semiconductors, memory semiconductors including DRAMs.

Table 2-1 Number of employees in the semiconductor industry by sector
(as of the end of 2022, unit: number of employees, %)

Sector	Memory semiconductors	System semiconductors	Process equipment	Semiconductor materials	Total
Number of employees	16,996 (11.6)	20,247 (13.8)	41,240 (28.1)	68,269 (46.5)	146,751

Source: Survey on the Actual Situation of the Employment Transition of Semiconductor Manufacturing Industry (2023), Korea Employment Information Service.

Educational background of the industrial technology human resources in the semiconductor industry is as follows[20]: high school graduates (29.5%), graduated with bachelor's degrees (11.0%), graduates of vocational schools (9.3%), graduated with master's degrees (3.4%), graduated with doctoral degrees (1.3%), which is similar to 12 major industries[21] (see Table 2-2). A total of 4.7% of the employees engaged in research and development (R&D) in the semiconductor industry hold master's or doctoral degrees—2.5% higher compared to the 2.2% in 12 major industries. This shows that the employees in the semiconductor industry have higher educational backgrounds compared to other industry sectors.

Table 2-2 Number of employees in the semiconductor industry by educational background
(as of the end of 2022, unit: number of employees, %)

Classification		Non-industrial technology human resources	Industrial technology human resources					Total
			High school graduates	Vocational school graduates	Graduates with bachelor's degrees	Graduates with master's degrees	Graduates with doctoral degrees	
Semiconductor industry	Number of employees	90,770	59,013	18,667	21,928	6,875	2,531	199,784
	Ratio	45.4	29.5	9.3	11	3.4	1.3	100
12 major industries	Number of employees	1,338,440	579,428	190,419	304,330	44,532	9,780	2,466,929
	Ratio	54.3	23.5	7.7	12.3	1.8	0.4	100

Source: Survey on the Actual Situation of Demand on Human Resources of Semiconductor Manufacturing Industry (2023); Ministry of Trade, Industry and Energy.

Table 2-3 presents the number of employees for each job classification by educational background. Jobs related to semiconductors can be classified into eight types: R&D, and design—these are prior to manufacturing; manufacturing technologies; manufacturing functions; simple manufacturing jobs; and test/evaluation/quality management, which are related to actual semiconductor manufacturing; and office work and service job, which are not directly related to manufacturing of semiconductors itself. Employees working in R&D are responsible for the development of next-generation semiconductor technologies and research on mass production of the developed products. Design jobs entail

[20] The industrial technology human resources are the employees having higher educational background than high school graduates working in R&D, in technical positions, managers engaged with manufacturing or information communication operations, or corporate executives.

[21] The 12 major industries selected by the Industrial Research Institute—a national research institute under the Ministry of Trade, Industry and Energy—include machinery, display, semiconductor, bio-health, textile, automobile, electronics, shipbuilding, steel, chemical, software, and IT business industries.

designing analog circuits, digital IPs, optimized blocks, chip layout, etc. Difference between jobs in manufacturing technologies, jobs in manufacturing functions, and simple manufacturing jobs lies in their level of expertise. Manufacturing technologies jobs require technological expertise while manufacturing function jobs and simple manufacturing jobs are related to operation, service, and maintenance of equipment[22].

Regarding educational background of employees having jobs except the ones that do not require expertise, that is, jobs in manufacturing functions and simple manufacturing jobs, the percentage of university graduates is high—particularly high, more than 80%, for employees with design jobs (85.1%) and employees with office work (80.4%). Conversely, the percentage of vocational school graduates is highest for employees with jobs in manufacturing functions (47.5%). Regarding simple manufacturing jobs, the percentage of employees who are high school graduates or less is highest (67.9%), indicating that these jobs do not require a higher level of education. The percentage of employees with educational backgrounds of university graduates or higher for R&D jobs is 92.7% and for design jobs is 96.3%—this indicates that these jobs require a higher level of education. A total of 35.7% employees—that is, more than one in three—with R&D jobs have a master's or higher degree.

Table 2-3 Educational background of employees of each job classification in the semiconductor industry (as of the end of 2022, unit: number of employees, %)

Educational background	High school graduates or less	Vocational school graduates	Graduates with bachelor's degrees	Graduates with master's degree/doctoral degrees	Total
Research and development	-	1,338 (7.3)	10,450 (57.0)	6,536 (35.7)	18,323
Design	-	598 (3.8)	13,575 (85.1)	1,781 (11.2)	15,955
Test/evaluation/verification	4 (0.1)	1,360 (20.9)	4,265 (65.6)	873 (13.4)	6,503
Manufacturing technologies	816 (4.2)	3,859 (19.7)	13,969 (71.3)	939 (4.8)	19,583
Manufacturing functions	14,042 (31.9)	20,935 (47.5)	9,076 (20.6)	15 (0.03)	44,067
Simple manufacturing	8,655 (67.9)	3,426 (26.9)	667 (5.2)	-	12,748
Office work	294 (1.5)	2,968 (14.7)	16,185 (80.4)	694 (3.4)	20,140
Service	321 (3.4)	2,338 (24.8)	6,367 (67.5)	405 (4.3)	9,432
Total	24,132 (16.4)	36,823 (25.1)	74,553 (50.8)	11,243 (7.7)	146,751

Source: Survey on the Actual Situation of the Employment Transition of Semiconductor Manufacturing Industry (2023); Korea Employment Information Service.

Table 2-4 presents the number of employees with each educational background for each sector in the semiconductor industry. The percentage of employees with a master's or higher degree is highest for memory semiconductors (13.2%), that of university graduates is highest for semiconductor process equipment (55.2%), that of vocational school

[22] Individuals with manufacturing technologies jobs are responsible for the technical aspect of operations on finished products or manufacturing parts based on the knowledge and experience in semiconductor-related technologies; individuals with jobs in manufacturing functions directly participate in the manufacturing process of semiconductor-related products or parts, and are responsible for functional jobs such as manufacturing, operation, etc., of machinery and equipment. Those with simple manufacturing job are in charge of simple operations in the semiconductor manufacturing process.

graduates is highest for system semiconductors, and that of high school graduates or less is highest for semiconductor materials (19.9%).

Table 2-4 Number of employees with each educational background for each sector in the semiconductor industry (as of the end of 2022, unit: number of employees, %)

Educational background	High school graduates or less	Vocational school graduates	Graduates with bachelor's degrees	Graduates with master's degree/doctoral degrees	Total
Memory semiconductors	2,066 (12.2)	3,661 (21.5)	9,034 (53.2)	2,235 (13.2)	16,996
System semiconductors	25.26 (12.5)	6,571 (32.5)	9,364 (46.3)	1,785 (8.8)	20,247
Process equipment	5,976 (14.5)	10.193 (24.7)	22,763 (55.2)	2,309 (5.6)	41,240
Semiconductor materials	13,564 (19.9)	16,398 (24.0)	33,393 (48.9)	4,914 (7.2)	68,269
Total	24,132 (16.4)	36,823 (25.1)	74,553 (50.8)	11,243 (7.7)	146,751

Source: Survey on the Actual Situation of the Employment Transition of Semiconductor Manufacturing Industry (2023); Korea Employment Information Service.

As a summary for the educational background of each job/sector in the semiconductor industry, the largest number of employees with a master's degree or higher qualification are in R&D jobs, and in terms of business sector, in memory semiconductors. This is because R&D is mainly conducted by major memory semiconductor manufacturers such as Samsung Electronics and SK Hynix. The percentage of university graduates is the highest in all fields with 50% or more, except for jobs in manufacturing functions and simple manufacturing jobs. The proportion of vocational school graduates is the highest in jobs in manufacturing functions and sector of system semiconductors. The proportion of employees with an educational background of high school graduates or lower is higher in simple manufacturing jobs and in jobs in semiconductor materials.

2.2 Supply of Human Resources for each Type in the Korean Semiconductor Industry

Table 2-5 presents the trend in the number of employees with each educational background in the semiconductor industry. The proportion of industrial technology human resources is increasing every year—approximately 23% (20,487 employees) increase was recorded in 2022 compared to the 2013 numbers, resulting in 109,014 employees. The educational background that showed the highest increase during the 10-year period was among high school graduates (45%), followed by vocational school graduates (20%), and graduates with doctoral (11%), bachelor's (-2.4%), and master's (-9.5%) degrees. Table 2-6 presents the trend in the number of employees of industrial technology human resources for each educational background in the 12 major industries. The total number of employees increased by approximately 11% in 10 years, with the highest increase in high school graduates (18.4%), followed by those with a bachelor's degree (6.8%), vocational school graduates (3.5%), doctoral degree holders (-1.3%), and master's degree holders (-6.5%).

The rate of increase in the number of employees in the semiconductor industry is more than twice compared with 12 major industries. The rate of increase in the number of high school graduates is the highest, as with other industries. Meanwhile, the rate is higher in the semiconductor industry than in other industries. The rate of increase

in the number of vocational school graduates is also high in the semiconductor industry. Regarding employees with a doctoral degree, 12 major industries showed a negative increase rate (decrease) while the semiconductor industry showed a high increase rate of more than 10%.

Table 2-5 Trend in the number of employees with each educational background in the semiconductor industry

Educational background	High school graduates or less	Vocational school graduates	Graduates with bachelor's degrees	Graduates with master's degrees	Graduates with doctoral degrees	Total
2013	40,647	15,537	22,467	7,596	2,280	88,527
2014	43,078	14,061	23,276	8,096	2,601	91,112
2015	38,370	15,780	25,260	8,532	2,551	90,493
2016	40,885	13,308	22,537	7,355	2,440	86,525
2017	51,215	14,745	17,578	6,004	959	90,501
2018	50,411	15,292	19,365	5,746	2,058	92,872
2019	51,758	15,453	19,931	6,098	2,188	95,428
2020	53,697	16,972	20,001	6,404	2,211	99,285
2021	56,130	17,757	20,948	6,706	2,464	104,005
2022	59,013	18,667	21,928	6,875	2,531	109,014

Source: Survey on the Actual Situation of Demand on Human Resources of Semiconductor Manufacturing Industry (2014–2023); Ministry of Trade, Industry and Energy.

Table 2-6 Trend in the number of employees with each educational background in 12 major industries (unit: number of employees)

Educational background	High school graduates or less	Vocational school graduates	Graduates with bachelor's degrees	Graduates with master's degrees	Graduates with doctoral degrees	Total
2013	489,416	184,061	285,028	47,651	9,912	1,016,068
2014	507,471	189,080	287,629	47,743	9,582	1,041,505
2015	523,852	197,267	277,806	48,378	10,008	1,057,311
2016	542,386	192,035	291,823	40,132	8,192	1,074,568
2017	569,217	187,123	290,458	41,144	6,371	1,094,313
2018	570,543	185,898	294,199	41,560	8,905	1,101,105
2019	568,900	184,575	296,602	43,014	9,029	1,102,120
2020	565,056	184,934	296,641	43,231	9,059	1,098,921
2021	573,376	188,338	300,134	44,084	9,594	1,115,526
2022	579,428	190,419	304,330	44,532	9,780	1,128,489

Source: Survey on the Actual Situation of Demand on Human Resources of Semiconductor Manufacturing Industry (2014–2023); Ministry of Trade, Industry and Energy.

2.3 Current Situation and Future Outlook of Human Resources Demand in the Korean Semiconductor Industry

In the Semiconductor-Related Human Resources Development Plan developed in 2022, the Korean government cited a document published by the Semiconductor Industry Association in 2022 expecting the demand for semiconductor industry human resources increasing to 304,000 employees in 2031. This is a forecast of increase of 127,000 employees from the current workforce size of 177,000 employees where human resources of the industry are assumed to grow by average of 5.6% annually as the industry expands. Table 2-7 presents the forecast of increase in the number of employees for each semiconductor sector and educational background published by the Semiconductor Industry Association in 2022. The semiconductor industry is classified into semiconductor manufacturing and semiconductor foundation, and forecast of increase in each sector and educational background is presented. Rate of increase for

human resources with doctoral degrees is the highest for both sectors[23].

Table 2-7 Current situation and future outlook of number of employees in each semiconductor industry sector and educational background (unit: number of employees, %)

Sector	Educational background	Number of employees			Increase in the number of employees	Average annual increase rate
		2021 (A)	2026 (B)	2031 (C)	(C) - (A)	(A) to (C)
Semiconductor manufacturing	High school graduates	39,015	52,428	70,362	31,347	6.1
	Vocational school graduates	14,964	19,347	24,980	10,015	5.3
	Graduates with bachelor's degrees	53,849	69,157	88,701	34,852	5.1
	Graduates with master's degrees	18,135	23,976	31,658	13,523	5.7
	Graduates with doctoral degrees	7,516	10,432	14,461	6,945	6.8
	Sub total	133,479	175,341	230,162	96,683	5.6
Semiconductor foundation	High school graduates	5,059	6404	8099	3040	4.8
	Vocational school graduates	7,793	10,326	13,667	5,874	5.8
	Graduates with bachelor's degrees	26,948	35,388	46,423	19,475	5.6
	Graduates with master's degrees	2,921	3,785	4,900	1,979	5.3
	Graduates with doctoral degrees	309	463	692	382	8.4
	Sub total	43,030	56,366	73,781	30,751	5.5
Total		176,509	231,706	303,943	127,434	5.6

Source: Future Outlook of the Demand on Human Resources of Semiconductor Industry, Korea Semiconductor Industry Association (2022)

As discussed above, an additional demand of 127,000 employees is expected by 2031 compared to 2021. However, in 2020, graduates of vocational high schools, vocational schools, undergraduate courses, and master's degree courses or higher were approximately 1,300, 1399, 1,928, and 431, respectively—a total of approximately 5,000. If this level of human resources supply persists for another decade, the total of employees added will be approximately 50,000 people—significantly less than the required 127,000. As a response, the government announced the Semiconductor-Related Human Resources Development Plan in 2022 with the target of raising 150,000 or more new semiconductor personnel by 2031.

The government cited the forecast by the Semiconductor Industry Association in the Semiconductor-Related Human Resources Development Plan to reflect the opinion of the industry regarding the issue of supply of human resources. This forecast, however, is based on the increase in semiconductor production according to the estimation by the K-Semiconductor Strategy announced by the government in 2021. This strategy aims to add 36,000 new employees, and, therefore, it is criticized as an overestimation. This issue was discussed in the Policy Counsel of Government and Ruling Party Counsel at the National Assembly in 2022 for enhancing competitiveness of the semiconductor industry. Revised values may be applied for future policy targets.

[23] The semiconductor manufacturing sector includes device/design-related companies that manufacture semiconductors, and the semiconductor foundation

2.4 Issues of Supply and Demand Situation of Human Resources in Korean Semiconductor Industry

To summarize the discussion thus far, the Korean government seeks not only to maintain competitiveness of the Korean memory semiconductor industry but also to make Korean companies in the industry competitive, including system semiconductor manufacturers and semiconductor materials, parts, and equipment companies. The Korean government has determined that expanding human resources in the industry is critical, and is, therefore, developing and promoting related policies. Major challenges when deploying such human resources policies can be (i) imbalance between supply and demand of human resources in the industry, and (ii) diversification of human resources demand with technology innovation. We analyzed each item based on the opinions of individuals involved in education and the industry through interviews.

2.4.1 Imbalance of human resources demand and supply in industries

Demand for human resources is expected to rise drastically in the semiconductor industry, and if supply of suitable graduates remains at the current level, the demand–supply imbalance will exacerbate. According to the estimation by the Semiconductor Industry Association in 2022, the number of employees in the semiconductor industry is expected to increase to 304,000 in 2031 from 177,000 in 2021—an increase of 127,000; meanwhile, the supply of human resources related to the semiconductor industry as of 2021 is approximately 5,000 annually, and if the supply remains at this level, shortage of approximately 77,000 employees is expected in 2031.

In addition to the absolute shortage of human resource, there is another issue: the semiconductor industry is not very popular among students who study semiconductor-related subjects. A survey conducted by the Education Department with 50 universities revealed that among the graduates who studied semiconductor-related subjects, only 33.1% obtained a job in the semiconductor industry[24]. A total of 66% of the students who chose a job in the semiconductor industry—33.1% of the total number of graduates—had graduated from vocational schools, and only 11.3% of students who received higher education chose the semiconductor industry as their area for work. It is assumed that such a situation is induced by the absence of a human resources development strategy led by government and a lack of motivation to work in the semiconductor industry. Therefore, the Korean government assists the students studying semiconductor-related subjects to obtain a job within the industry through cross-ministry support and promotes specific support for each sector of the semiconductor industry.

The semiconductor industry is less attractive to new graduates compared to other industries. The main reasons are low wages, poor working conditions, including shift work, and rural locations. In the Survey on the Supply and Demand of Industrial Technology Personnel in 2023, 46.8% of the respondents indicated that the wage level was the reason for the lack of employees in the semiconductor industry in the previous year, which was more than twice the level of the software industry (18.0%) and the IT industry (13.5%)[25]. Even the interviewees indicated that poor work

[24] The above-cited survey was conducted by the Education Department from August 2021 to February 2022 based on the health insurance data of individuals who graduated from semiconductor-related departments of 50 universities to obtain employment status. Details of the survey are not disclosed.

[25] Refer to the Survey on the Supply and Demand of Industrial Technology Personnel (2023); the Ministry of Trade, Industry and Energy.

conditions in domestic companies is the main reason for the shortage of employees in the semiconductor industry. The average wage in the software industry, which is popular among science and engineering graduates, is higher than that in the semiconductor industry (see Table 2-8).

Table 2-8 Average wages of employees in software industry (2022, unit: won)

Industry	Job category	Average annual wage
Semiconductor	Semiconductor in general	80,700,000
Software	IT planning/consulting	110,505,261
	IT project management	114,519,108
	IT architecture	128,070,360
	Software development	66,052,395

Source: Indices of Major Industry Trend, Industrial Research Institute (2024); Survey on Actual Situation of Wages of Software Engineers, Korea Labor Institute (2023)

Demand for experienced employees who can readily contribute their expertise at the workplaces is higher in the semiconductor industry compared to other industries (see Table 2-9) owing to the dissemination of Mega Trends such as AI and autonomous driving, and required rapid response to technological advancement.

Table 2-9 Status of recruitment of experienced personnel in the semiconductor industry and 12 major industries (2022, unit: number of employees, %)

Classification	Recruiting personnel			
	Total	Experienced personnel	New graduates	Foreign personnel
Semiconductor industry	5,657 (100.0)	3,489 (61.7)	2,168 (38.3)	0 (0.0)
12 Major industries	112,605 (100.0)	59,196 (52.6)	52,951 (47.0)	459 (0.4)

Source: Survey on the Actual Situation of Demand on Human Resources of Semiconductor Manufacturing Industry (2023); Ministry of Trade, Industry and Energy.

The semiconductor industry requires personnel who can help respond to rapidly evolving industry trends as well as serve in small-to-medium-scale design, materials, parts, and equipment companies in this industry, which lack resources, time, and/or budget. These are the reasons why the industry demands more experienced personnel that can readily contribute to daily work than other industries. In the case of the semiconductor industry, unlike the software industry, direct operation of on-site equipment is a must; therefore, even a university-educated individual requires one to two years of practical experience to get accustomed to the operations in this industry. Usually, new hires require at least five or more years for high-level education and training, which is why companies in the semiconductor industry seek experienced personnel.

In this context, departments and subjects related to semiconductors are newly established, led by the government, so that practical education suitable for the industry can be implemented. However, in the educational context, there exists a concern that core value of education may shift from basic academic education to practical training. Actually, within

a university where a contract department was established, two positions coexist: to reflect the needs of contractor companies to the maximum, and to impart solid basic knowledge to students—the main purpose of a university. An interviewee indicated that well-balanced education for a long-term human resources development strategy meeting the needs of both the industry and academia should be implemented by devising an educational structure that focuses on developing specific human resources in accordance with the characteristics of universities and each field.

2.4.2 Diversification of human resources demand with technology innovation

As discussed above, the government expects an increase in the demand for human resources for the semiconductor industry. The 4th Industrial Revolution is expected within the semiconductor industry, and rapid growth of the industry is anticipated owing to the increasing demand for semiconductors in various fields. Trends in major semiconductor-related technologies including next-generation mobile communication, AI, and autonomous driving are examined to analyze their impact on demand for human resources.

(i) Semiconductors for next-generation mobile communication

In the telecommunication field, semiconductors are utilized in almost all the devices supporting transmitting/receiving, processing, and data saving. Telecommunication technologies have advanced progressively each with a period of about 10 years. Next-generation 6G communication technology—an advanced version of the current 5G—is expected to be commercially available by 2028. 6G technology realizes super high-speed data transmission and large-scale connection, thereby contributing to digitalization of existing industries and creation of new business models. To realize the 6G technology, increasing the data transmission capacities and rates for both the wired and wireless connections is necessary. The complementary metal-oxide semiconductor (CMOS) and compound semiconductor technologies that can improve the mobility of electrons in the semiconductors are required in the telecommunication semiconductor sector[26].

Conversely, securing and developing source technologies for commercialization of 6G technology is necessary for the Korean semiconductor industry related to mobile telecommunication. Currently, US companies possess the most advanced technologies in this field. The Korean government commented that the level of technology Korean companies hold is only 70 to 80% of the technology held by their American counterparts.

Considering the situation, the Korean government announced the Future Semiconductor Technology Roadmap where advancement of beam-forming semiconductor at upper-mid band[27] and CMOS/compound semiconductor processes are promoted to realize next-generation mobile communication in the short term, and promoting performance optimization of 6G mobile communication semiconductors and advancement of CMOS/compound semiconductor processes to stay ahead of standardization of next-generation mobile communication in the medium to long term. The government also continues to support the program for developing human resources with master's and doctoral degrees, and assisting the graduates to obtain a job within the industry so that specialized human resources at specific sectors are supplied continuously.

[26] When applying the CMOS technology, the process becomes more complex while the device can operate at higher speed with less power consumption.

[27] 7 to 24 GHz frequency band recognized as the candidate for 6G communication.

Samsung Electronics is actively recruiting human resources and investing in mobile communication semiconductors. It announced an investment plan of 180 trillion won for future-growth businesses in 2018, and identified AI semiconductors and telecommunication semiconductors as future-growth areas. Thereafter, in 2021, it established an 8nm radio frequency process technology to strengthen the telecommunication semiconductor foundry business and in 2024, announced the launch of single instruction multiple data technology development, which is necessary for 6G semiconductors, in collaboration with ARM, an English semiconductor design firm. Regarding recruitment, the company announced a plan in 2020 to hire 1,000 personnel with master's or doctoral degrees for semiconductor design and future-growth business sectors. It actually hired more than 500 individuals with doctoral degrees during the first half of 2020.

As shown above, government-led R&D support strategy and active technology investment and recruitment by large enterprises are implemented in the next-generation mobile communication semiconductor field. As Korean companies lag behind foreign companies—especially in the US—in terms of technology, demand for high-level human resources suitable for technology development and design will be steadily generated.

(ii) AI semiconductors

As the global AI market is rapidly growing, governments of major countries have specified AI technology as a strategic asset. Demand for AI semiconductors is also increasing. According to the Korea Information Society Development Institute, the AI semiconductor market will be worth USD 159 billion 22 million in 2028[28]. The AI semiconductor defined by the Korean government is a semiconductor that executes complex calculations necessary for implementing AI services such as learning and inferring, with high performance and significant power efficiency. Currently, AI semiconductors are utilized in various fields including home appliances, wired/wireless communications, computing, automobiles, etc. In future, their application will further expand owing to the wide availability of on-device AI.

With growth of the AI semiconductor market and expansion of global competition, the Korean government supports R&D projects for assuring source technologies of the AI semiconductors through national strategic program such as the Future Semiconductor Technology Roadmap announced in April 2023 and the AI Semiconductor Initiative announced in April 2024. Specifically, the government supports the development of source technologies such as high-performance NPU technology and processing-in-memory technology[29] in the short term, while, in the medium to long term, it supports the realization of higher performance AI semiconductors based on the developed technology. Korean companies also focus on the development of related technologies and assuring human resources to enhance competitiveness in the AI semiconductor market. SK Hynix dominates the HBM market, core parts of AI semiconductors, and has accelerated the development schedule of HBM4, the 6th generation HBM, to strengthen the initiative in the AI memory semiconductor market. Additionally, it has hired personnel with experience in chip on wafer on substrate, 2.5D/3D system in package), and HBM technologies at a factory planned for construction in Indiana, US to promote R&D of the advanced packaging of AI semiconductors.

The government, industry, and academia share the importance of developing and recruiting of AI semiconductor-related human resources. At the AI Mobility New Technology Strategy Breakfast Forum held in Korea in December 2024, member of the National Assembly's Science, Technology, Information, Broadcasting and Communications

[28] This figure corresponds to 20.4% of total semiconductors market or 35.0% of system semiconductor market.

[29] PIM is a memory semiconductor that can execute data storage and processing simultaneously. When applied to an AI semiconductor, it can improve power efficiency by reducing data transfer between CPU and memory semiconductors.

Committee, president of Jeonbuk National University, and DEPPX—an AI semiconductor fab-less company—noted that collaboration among base universities, the government, and companies is important for expanding the domestic AI semiconductor industry and enhancing competitiveness of fab-less companies. AI semiconductors have become high-mix, high-performance with diversification of demand, and SMEs capable of design functions are expected to expand. Therefore, developing design personnel working at SMEs is indispensable, and development of AI semiconductor-related human resources at base universities is expected to expand.

(iii) Automotive semiconductors

Automotive semiconductors are a generic term for semiconductors used in automobiles. It mainly recognizes information on safety conditions of automobiles and passengers for analysis and assessment to control and drive the automobile. Automotive semiconductor market is expected to grow rapidly from now on similarly to other next-generation semiconductor fields because of factors such as development and proliferation of autonomous driving cars, improvement of automobile performance, etc. In the case of the autonomous driving cars, automotive semiconductors are used in sensors, cameras, driving assist systems, etc. It is expected that the conventional single-chip structure will be replaced by large-capacity memories such as HBM and chiplet structure with advanced packaging technologies with the advancement of automobile-related technologies.

The Korean government also pays close attention to the growth of the automotive semiconductor market, announcing support policy to improve and secure source technologies. Related technologies are led by US companies followed by European and Chinese companies, with Korean companies lagging behind. To catch up, the Korean government announced the Future Semiconductor Technology Roadmap in April 2023 to propose a course of action of R&D of the automobile semiconductor sector. It specifies three core fields: (i) processor, (ii) sensor, and (iii) mixed signal, to enhance competitiveness in the automotive semiconductor sector. The government adopted a policy to promote early commercialization of current domestic products that can be used as automotive semiconductors and advancement of existing technologies in the short term, and a medium to long-term policy to promote investment in the range of 650 billion won in technologies that require medium to long-term large-scale investment based on future demand from companies.

Korean companies actively address the automotive semiconductor market as well. In 2023, Samsung Electronics declared that it would become the top automotive memory supplier worldwide by 2025. The company promotes development and securing of related technologies. At the Automotive Electronics Forum 2024 held in the US, the company announced that it is currently developing automotive HBMs having five-times or more memory capacity and bandwidth compared to conventional low power double data rate memory. Sales of automotive semiconductors by AD technology—a Korean design house company—were 12% of the total sales in 2024, compared to 7% in 2023. The company is actively hiring design personnel for custom-made semiconductors including automotive and AI semiconductors. In 2023, DB Hitek—a foundry—announced a factory expansion plan for the production of the next-generation high-power semiconductors and custom image sensors as an expansion strategy of power management IC product portfolio, which is their mainstream product. Additionally, the company announced plans for a long-term supply contract with Tesla—a global EV maker. As domestic companies promptly respond to the increasing demand for automotive semiconductors, demand for human resources in the related design and manufacturing sectors is expected to increase.

3 South Korea's Strategy and System for Semiconductor Human Resource Development

To support the growth of the semiconductor industry, South Korea has traditionally relied on contract-based programs led by major integrated device manufacturers (IDMs) to train and supply skilled workers. However, this approach has led to a significant shortage of talent.

In response, the South Korean government introduced the "Semiconductor-Related Human Resources Development Plan" in 2022 to expand the semiconductor workforce and attract a wider range of professionals, from entry-level workers to senior experts, to meet the industry's growing needs. As shown in Figure 3-1, the plan presents measures for developing semiconductor human resources across three dimensions: (1) development strategy, (2) support formats, and (3) the promotion framework.

This chapter analyzes the direction of the 2022 "Semiconductor-Related Human Resources Development Plan" from the perspectives of development strategy, support mechanisms, and promotion systems. It then examines the current implementation status of major government-led initiatives for semiconductor human resource development. The chapter also draws insights from the progress of South Korea's semiconductor workforce development projects. Furthermore, beyond government-supported and guided training initiatives, it explores trends in industry-led training programs to identify challenges related to talent development in the semiconductor sector.

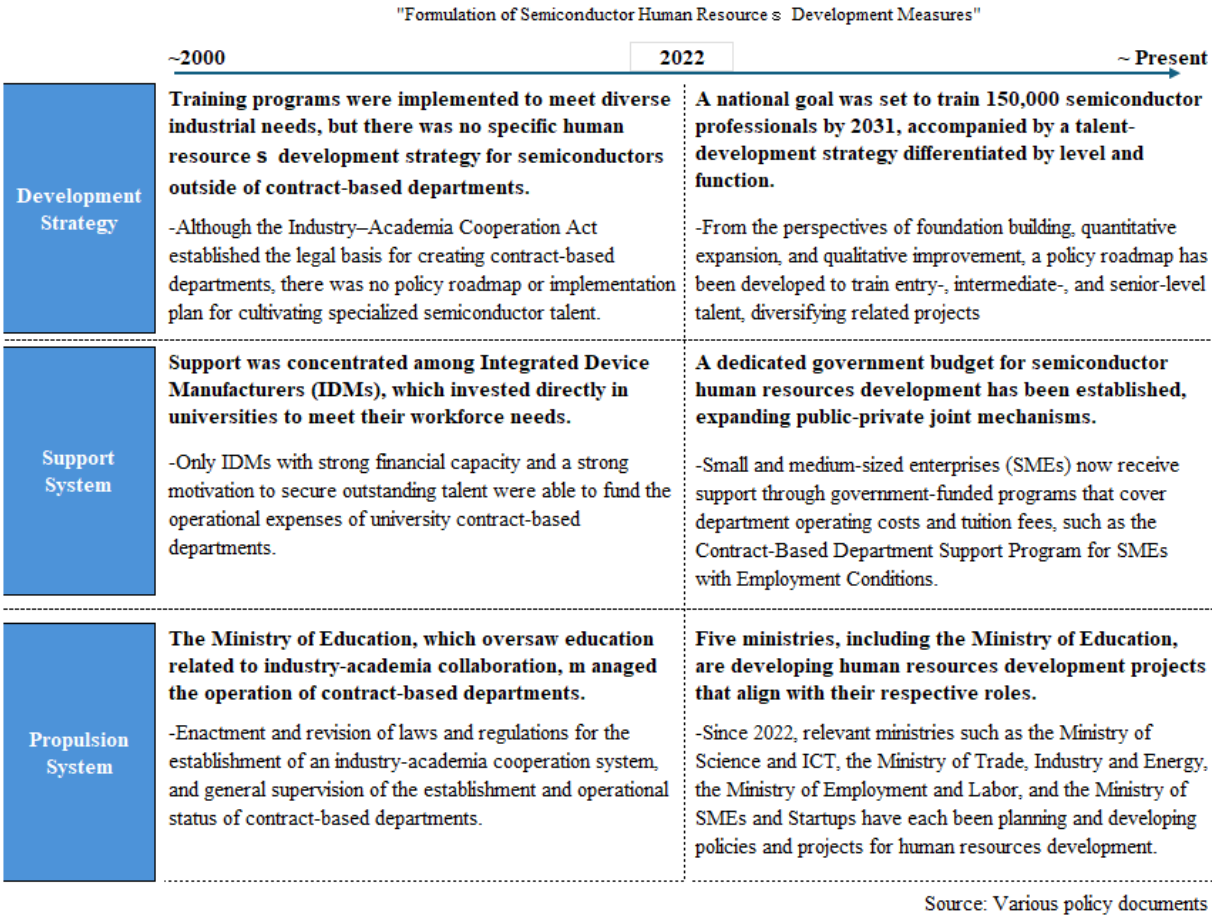


Figure 3-1 Changes in South Korea's Semiconductor Human Resource Development Policy

3.1 Semiconductor Human Resource Development Strategy

Before the introduction of the "Semiconductor-Related Human Resources Development Plan," South Korea's semiconductor talent development strategy, as shown in Figure 3-2, focused primarily on providing operational support for contract-based semiconductor departments at universities and graduate schools. This strategy aimed to nurture intermediate- to senior-level professionals. Following the establishment of the "Basic Plan for Human Resources Development" in 2002, the government emphasized expanding university–industry cooperation systems and promoting the exchange of highly skilled personnel to align technology development and talent training with industry needs. Consequently, the Industry-Academia Cooperation Act (Industrial Education Enhancement and Industry-Academia-Research Cooperation Promotion Act) was amended in 2003 to establish a legal foundation for "contract departments" where companies collaborate with educational institutions to offer specialized curricula. In 2006, Samsung Electronics and Sungkyunkwan University created the first conditional employment contract departments in the semiconductor field. Later, in 2009, SK Hynix and Korea University established graduate-level contract departments with employment conditions to train master's and doctoral-level talent. Until 2022, the government's role remained largely supplementary, providing support for corporate initiatives without introducing any government-led policies specifically targeting talent cultivation in the semiconductor sector.

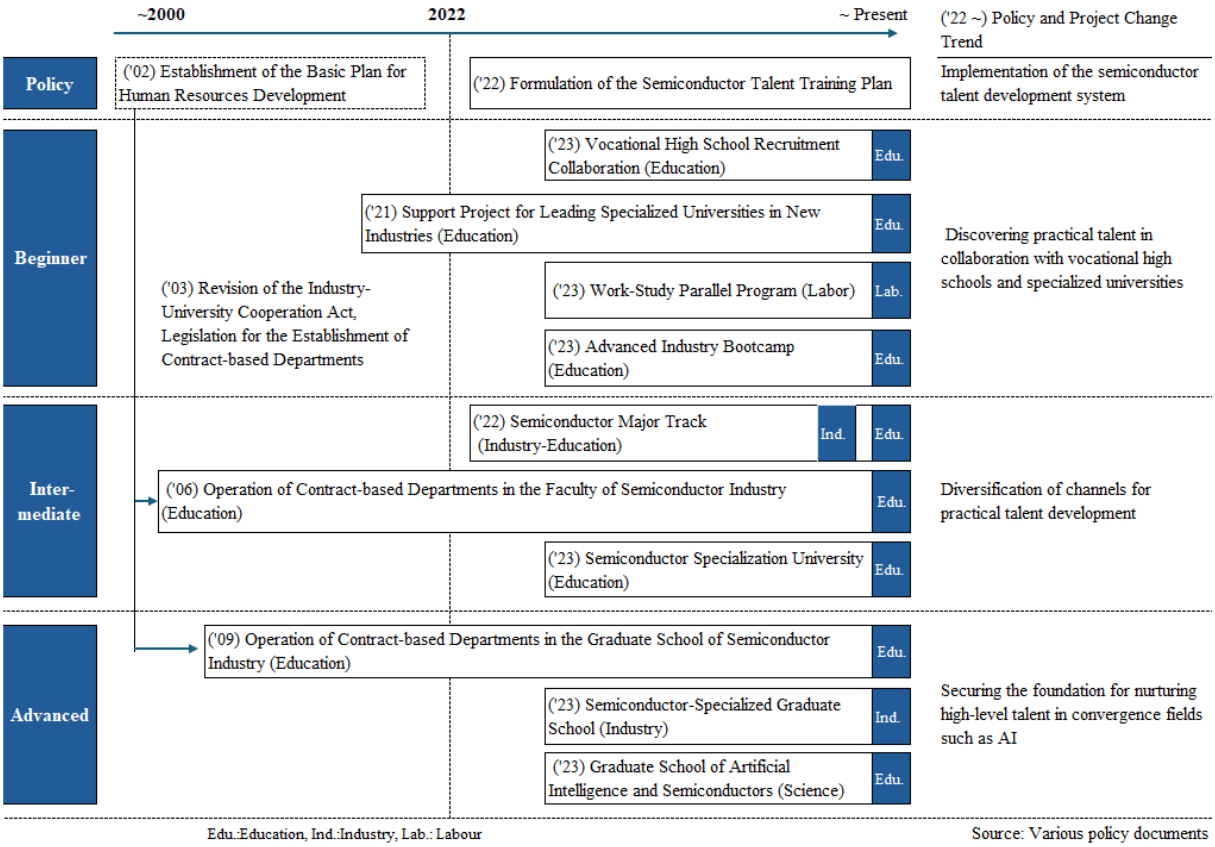


Figure 3-2 Changes in South Korea's Semiconductor Human Resource Development Strategy and System

However, since the late 2010s, the emergence of artificial intelligence (AI) has increased the demand for advanced semiconductors such as high-bandwidth memory (HBM), thereby elevating the economic importance of the semiconductor industry. Recognizing the potential severity of the semiconductor talent shortage, the South Korean government introduced the "Semiconductor-Related Human Resources Development Plan" in 2022 to secure skilled professionals in this critical sector. The plan aims to train more than 150,000 semiconductor professionals by 2031 and outlines specific training frameworks tailored to entry-level, intermediate-level, and senior-level personnel. For entry-level workers, it promotes practice-oriented programs, including on-the-job training, at vocational high schools and technical colleges to develop talent that can be readily deployed in the industry. For intermediate-level professionals, the government has relaxed regulations on establishing contract-based programs to increase their availability and diversified practical training opportunities, such as by designating universities specializing in semiconductor education. For senior-level professionals, the plan supports the creation of graduate-level contract programs similar to undergraduate ones and encourages the establishment of new graduate programs specializing in advanced fields such as AI, semiconductors, and processing-in-memory (PIM) technologies, with the goal of cultivating next-generation semiconductor experts.

3.2 Support Structures for Semiconductor Human Resources Development

As discussed in the previous section, government-led talent development policies before 2022 were insufficient. As a result, companies had to take responsibility for training their employees and independently cover all related costs. Consequently, contract departments were mainly operated by large manufacturing firms with adequate financial resources and a strong motivation to secure highly skilled personnel. However, the introduction of the "Semiconductor-Related Human Resources Development Plan" fostered broad social consensus on the importance of securing semiconductor talent. This shift enabled the systematic cultivation of semiconductor professionals through public funding. For instance, the "Contract Department Program for Small and Medium-sized Enterprises (SMEs) with Employment Conditions," launched in 2023, is notable because it differs from the contract departments operated by large corporations. Under this program, the Ministry of SMEs and Startups provides financial support for both departmental operations and student tuition fees. A series of related policy measures have also been introduced to help small and medium-sized enterprises (SMEs) overcome their limited financial capacity and weaker competitiveness in attracting skilled professionals. These initiatives aim to empower SMEs by equipping them with the tools and resources needed to compete more effectively for top talent.

3.3 Promotion Framework for Semiconductor Human Resources Development

Since 2022, the government's semiconductor human resources development efforts have been coordinated by the Ministry of Education, with responsibilities shared among five ministries: the Ministry of Science and ICT, the Ministry of Trade, Industry and Energy, the Ministry of Employment and Labor, and the Ministry of SMEs and Startups. As shown in Figure 3-3, the Ministry of Education, as the coordinating body, is developing the infrastructure for semiconductor human resources and establishing a comprehensive support system to enhance both the quantity and quality of talent. In addition, the Ministry of Science and ICT and the Ministry of Trade, Industry and Energy are establishing new graduate schools to cultivate highly skilled professionals and designing curricula tailored to industry needs, in coordination with the Ministry of Education's policies. Meanwhile, the Ministry of Employment and Labor and the Ministry of SMEs and Startups are implementing measures to stabilize the supply and demand of human resources across the semiconductor industry and assist SMEs in securing skilled semiconductor personnel.

This section outlines the support programs implemented by these five government agencies. The next section categorizes these programs by type and provides detailed descriptions.

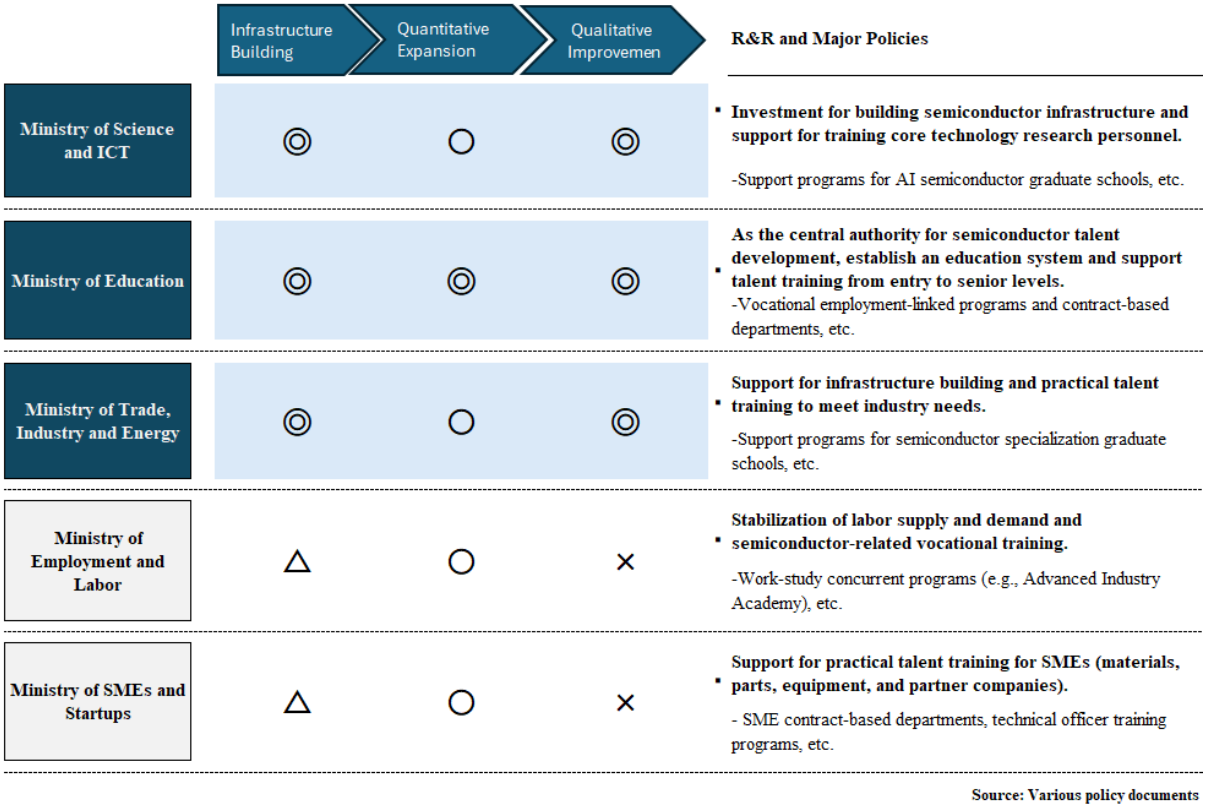


Figure 3-3 Roles and Key Promotion Policies by Ministry

South Korea's semiconductor human resource development measures categorize talent into entry, intermediate, and senior levels based on educational background and expected job responsibilities (Table 3-1). Entry-level talent refers to individuals with an associate degree or lower who are primarily responsible for production and operational management in semiconductor manufacturing facilities. Intermediate-level talent includes those with bachelor's degrees and who are engaged in planning, research, and other general semiconductor-related tasks at corporate headquarters. Senior-level talent refers to individuals with a master's degree or higher who handle advanced technical research and development duties at headquarters or affiliated research institutes.

Table 3-1 Classification of Talent for Development

Category	Educational Level	Expected Duties
Entry Level	Associate degree or below	Production and operations management in semiconductor manufacturing facilities
Intermediate Level	Bachelor's degree	Headquarters-based planning and research center for all semiconductor-related matters
Senior Level	Master's degree or higher	Advanced technical research and development at headquarters or research institutes

3.3.1 Ministry of Science and ICT

(1) Role

The Ministry of Science and ICT (MSIT) is responsible for formulating policies that promote the advancement of science and technology in South Korea. It also fosters research and development (R&D) initiatives and cultivates scientific and technological talent. In the context of semiconductor talent development, the ministry primarily focuses on implementing R&D budgets to build the infrastructure necessary for semiconductor technology research. Additionally, it is committed to supporting the training of senior-level professionals, including researchers specializing in core technologies for next-generation semiconductors.

(2) Promoted Initiatives

Initiatives such as the "Graduate School Support Program for AI Semiconductors" and the "System Semiconductor Convergence Specialist Training Center" have established specialized curricula for next-generation semiconductor subfields at graduate schools and research institutions. These initiatives have also provided research equipment and enhanced the overall environment for technical research (see Table 3-2). In 2022, the "PIM Semiconductor Design Research Center" was established to enhance PIM's semiconductor technical capabilities and function as a collaborative hub between industry, academia, and research. The center provides education programs to cultivate experts in PIM design, including through the "PIM Elite Talent Training Program."

Table 3-2 Examples of Promotion Projects by the Ministry of Science and ICT

	Graduate School Support Program for AI Semiconductors	System Semiconductor Convergence Specialist Training Center Project	PIM Semiconductor Design Research Center (PIM HUB)
Start Year	2023	2021	2022
Target Talent	Senior	Senior	Senior
Business Objective	Infrastructure d evelopment and quality enhancement	Infrastructure development and quality enhancement	Infrastructure development and quality enhancement
Support Details	Support for establishing and operating graduate schools in the fields of artificial intelligence, semiconductor design, and software.	Establishment and operational support for a talent development center providing comprehensive technical education in system semiconductors across five fields: artificial intelligence, Internet of Things (IoT), automotive, and related areas.	Establishment of the PIM talent development program (PIM Elite) and development and dissemination of PIM semiconductor-specific educational content and curriculum.

Source: Various policy documents

3.3.2 Ministry of Education

(1) Role

The Ministry of Education is responsible for formulating and implementing talent development policies, improving the primary and secondary education systems, and establishing fundamental policies for higher education. It also plays a coordinating role in the development of talent for the semiconductor industry. The ministry establishes an overarching educational framework and provides support for human resource development across all levels, from entry-level to senior-level professionals.

(2) Promotional Initiatives

The "Support Program for Job-Linked Curriculum in Vocational High Schools" provides job-specific education tailored to corporate needs for vocational high school students. The program facilitates employment through school–industry collaboration, thereby expanding the pool of entry-level talent. In addition, the Ministry has developed operational regulations for contract-based departments that target intermediate- and senior-level personnel to ensure their efficient establishment and operation. Specifically, for advanced industries such as semiconductors, improvements have been implemented, including the relaxation of previous restrictions on enrollment quotas (see Table 3-3).

Table 3-3 Examples of Initiatives Promoted by the Ministry of Education

	Support Program for Job-Linked Vocational Courses at Vocational High Schools	**Support for Establishing University Contract Programs with Employment Conditions**	**Expansion of Contract Programs with Employment Conditions at Graduate Schools**
Start Year	2023	2006	2009
Target Talent	Entry	Intermediate	Senior
Business Objectives	Quantitative expansion	Quantitative expansion	Qualitative improvement
Support Details	Providesing job training and collaboration with companies for vocational high school students	Establishment of employment support in operational regulations for contract-based academic programs and deregulation of enrollment quotas	(Same as the left column)

Source: Relevant policy documents

3.3.3 Ministry of Trade, Industry and Energy

(1) Role

The Ministry of Trade, Industry, and Energy oversees and coordinates policies related to trade, commerce, and industrial development. It is also responsible for formulating and implementing industrial technology R&D policies. In this context, semiconductor human resource development encompasses a wide range of efforts, from infrastructure development to the establishment of educational programs, aimed at cultivating talent that meets industry needs.

(2) Promotional Initiatives

The ministry has launched the "Semiconductor Academy Initiative." This initiative allows companies to train personnel according to their specific requirements. The initiative achieves this by designing the educational curricula that incorporate hands-on training using actual semiconductor manufacturing equipment. This equipment was used by both prospective and current employees semiconductor industry (Table 3-4).

Furthermore, through programs such as the "Semiconductor Specialization Track" and the "Semiconductor Specialization Graduate School Support Project," the ministry promotes collaboration between industry and academia, while developing the infrastructure needed to nurture intermediate-to-senior level professionals by providing educational facilities and technical equipment.

Table 3-4 Examples of Promotion Projects by the Ministry of Trade, Industry, and Energy

	Semiconductor Academy	Semiconductor Major Track	Graduate School of Semiconductor Technology
Start Year	2023	2022	2023
Target Talent	Entry/Intermediate (Those seeking employment in the semiconductor industry or current employees)	Intermediate	Senior
Business Objectives	Infrastructure development and quantitative expansion	Infrastructure development and quantitative expansion	Infrastructure development and quality improvement
Support Details	Implementing short-term, hands-on educational programs across diverse fields such as manufacturing processes and packaging.	Supporting the establishment and operation of semiconductor-specialized major courses and departments aligned with industry needs for undergraduate students.	Supporting the establishment and operation of graduate programs in cutting-edge industrial fields, including semiconductors.

Source: Relevant policy documents

3.3.4 Ministry of Employment and Labor

(1) Role

The Ministry of Employment and Labor is responsible for formulating and implementing policies related to employment and the labor environment. It also manages projects to develop and maintain the National Competency Standards (NCS), which define the skills and knowledge required to perform specific jobs. In the field of semiconductor human resource development, the Ministry primarily focuses on building talent management and support systems to ensure a stable supply of skilled professionals. It also promotes initiatives aimed at enhancing the vocational competencies of entry- and intermediate-level workers.

(2) Promotional Initiatives

Through the "Senior Industry Academy Program," which combines on-site corporate training with classroom instruction in related theories, the Ministry aims to stabilize the supply of new employees to semiconductor companies while reducing education and training costs (see Table 3-5). In addition, through initiatives such as the "Senior Industry Joint Training Center" and the "K-Digital Training Program," the Ministry builds infrastructure to help both employed workers and job seekers develop their vocational skills and participate in industry-aligned training programs.

Table 3-5 Examples of Programs Promoted by the Ministry of Employment and Labor

	Work-Study Program (Advanced Industries Academy)	**Advanced Industries Joint Training Center**	**K-Digital Training**
Start Year	2023	2023	2022
Target Talent	Entry	Entry	Entry/Intermediate
Business Objectives	Infrastructure development and quantitative expansion	Infrastructure development	Infrastructure development and quantitative expansion
Support Details	Implements a job-training system that provides simultaneous theoretical education and practical on-the-job training in the semiconductor and advanced industry sectors.	Conducts joint training programs with large corporations and SMEs in the semiconductor and advanced industry sectors, providing support for training facilities and equipment.	Operates educational programs that offer hands-on experience with practical projects in collaboration with companies in the semiconductor and IT sectors, and provide support for educational expenses.

Source: Relevant policy documents

3.3.5 Ministry of SMEs and Startups

(1) Role

The Ministry of SMEs and Startups aims to foster small- and medium-sized enterprises (SMEs) and startups by improving regulations and providing policy-based financial support. These efforts promote a cooperative ecosystem between large corporations and SMEs. In the semiconductor sector, the Ministry's initiatives have encouraged the development of practical training programs and strengthened the supply of skilled semiconductor professionals for SMEs. These SMEs include companies involved in materials, components, and equipment, as well as partner companies of major IDM firms (hereafter referred to as "partner companies").

(2) Promotional Initiatives

The Ministry promotes the "Contract Programs for SMEs with Employment Conditions" initiative, which provides financial support for operational costs and student tuition fees previously borne by large corporations under conventional contract programs. This enables SMEs to identify and cultivate talent that matches their specific workforce needs at an early stage (see Table 3-6). In addition, the "Technical Officer Training Program" is a four-year collaborative educational initiative that combines two years of study at specialized high schools (vocational high schools) with two years at technical colleges. The program systematically develops skilled personnel for SMEs engaged in the semiconductor and related industries.

Table 3-6 Examples of Programs Promoted by The Ministry of SMEs and Startups

	Hiring-Linked SME Contract Department Program	Engineering Officer Training Program
Start Year	2023	2023
Target Talent	Entry	Entry
Business Objectives	Infrastructure development	Infrastructure development
Support Details	Provides financial support for the operational costs of contract departments and for student tuition fees that were previously borne by companies.	Operates a collaborative educational program between specialized high schools and vocational schools to provide systematic talents for small and medium-sized enterprises.

Source: Relevant policy documents

3.4 Status of Semiconductor Human Resources Development Initiatives

3.4.1 Types of Semiconductor Human Resources Development Initiatives

Until the 2010s, South Korea's semiconductor human resources development strategies primarily focused on cultivating intermediate-level professionals through industry-led contract programs. However, as the semiconductor industry grew in strategic importance, the South Korean government announced the "Semiconductor-Related Human Resources Development Plan" in 2022. Since then, it has continued to promote various training support programs targeting different talent groups, with the aim of resolving recruitment challenges faced by semiconductor companies and securing advanced technological capabilities (see Table 3-7). This section categorizes the talent development policies implemented in South Korea's semiconductor industry, including existing corporate-led contract department programs, into four types, based on the timing and educational background of the talent being trained, as shown in Table 3-7. It also provides an overview of each program's content and implementation framework.

Table 3-7 Types of South Korean Government Support Programs for Semiconductor Human Resources Development

Business Categories	Related Businesses
Intermediate-Level Human Resource Development Program for Manufacturing Companies	Conditional Employment Contract Program (2006–)
Entry-Level Talent Development Program for Partner Companies	Specialized Leading Universities Support Program for New Industrial Fields (2021–) Conditional SME Contract Department Program (2023–) Vocational High School Recruitment Collaboration Job Process Support Program (2023–) Work-Study Concurrent Program (Senior Industry Academy) (2023–)
Process-Specialized Intermediate Human Resource Development Program	Semiconductor Specialization Track Program (2022–) Semiconductor Specialized University Support Program (2023–) Senior Industry Talent Development Bootcamp Program (2023–)
Technology Research-Oriented Senior Talent Development Program	Graduate School Support Program for Semiconductor specialized (2023–) Graduate School Support Program for Artificial Intelligence Semiconductors (2023-)

Source: Relevant policy documents

3.4.2 Intermediate-Level Talent Development Program for Manufacturing Companies

(1) Contract Programs with Employment Conditions (2006)

Business Overview	Degree programs established and operated through contracts between companies and educational institutions, where companies request the institution to establish the program with employment as a condition. Since the establishment of the first undergraduate program in early 2006, the number of programs has expanded.
Business Objectives	To cultivate specialized professionals who reflect industry needs and to enhance employment stability within the semiconductor workforce.
Target Talent	Intermediate and senior level
Support Details	Operating costs for contract programs are shared between companies and students according to agreed-upon ratios, but companies must bear at least half of the total expenses (though less than 50% is permitted outside the metropolitan area). Students receiving tuition support are obliged to work for the partner company for a period equivalent to a certain percentage of the support duration.
Program History	・2003: The introduction was made possible by the enactment of the "Industrial Education Enhancement and Industry-Academia-Research Cooperation Promotion Act", which established the legal basis. - Implemented comprehensive operational regulations, including provisions stipulating that companies must assume at least 50% of operating costs and impose enrollment caps. ・2018: The "Contract Department Establishment and Operation Regulations" were established to provide a comprehensive framework for the establishment and operation of contract departments. ・2023: Relaxed standards for establishing and operating contract departments through a partial amendment to the "Enforcement Order of the Industry-Academia Cooperation Act" related to contract departments. - Introduced a new quota system, eased corporate contribution requirements for universities outside the metropolitan area, and expanded corporate participation in student selection processes.

(A) Background and Recent Developments

In 2006, Samsung Electronics launched a contract-based undergraduate program at Sungkyunkwan University, participating directly in its operational foundation. The program was designed to ensure a stable supply of highly skilled semiconductor professionals. In 2009, SK Hynix established a contract-based graduate program at Korea University to promote semiconductor technology development and knowledge exchange.

As outlined in the 2022 “Semiconductor-Related Human Resources Development Plan,” which introduced policies to expand government support for semiconductor contract programs, the establishment of such programs has since expanded, primarily at top universities. Newly integrated bachelor’s–master’s programs have been established to cultivate senior-level professionals.

(B) Promotion system

Conditional contract departments are established in accordance with government regulations governing contract department operations. Under this framework, companies request educational institutions to establish departments, sign formal agreements, obtain approval from the Ministry of Education, and jointly develop and operate curricula in consultation with their partner institutions.

Organization Name	Responsible Role	Role Details
Ministry of Education	Legal basis preparation Establish and approve operations	・Approval of the operational agreement by the contract department management deliberation committee
Companies	Corporate education request Conclude operational agreement Cooperation in department operations. Tuition support and employment	・Requests for the establishment of a contract department - Concludes related operational agreements covering the program structure, student selection, curriculum, tuition burden, agreement period, etc. - Provide tuition and educational subsidies, and guarantee post graduation employment
Educational Institutions	Conclusion of Operations Agreements Academic Administration	- Research the subjects required by partner companies and incorporate them into the curriculum - Develop and operate curricula that reflect their needs, and plan and implement projects and events in collaboration with companies

(C) Educational Overview

Contract programs are operated by educational institutions that have entered into agreements with companies. Students enrolled in these programs receive tuition support, opportunities for research participation, and access to international exchange programs coordinated with industry partners.

Educational Institutions	Universities, industrial universities, specialized universities, distance learning universities, and other institutions capable of providing semiconductor-related education that meets corporate needs
Target Students	Students enrolled in contract programs
Operational Methods	・Educational institutions and companies jointly operate a Contract Program Steering Committee, conducting discussions and curriculum reviews at least once a year. ・Educational institutions develop curricula based on specialized fields, incorporating foundational, advanced (highly specialized), and practical training that reflects corporate needs. ・Companies provide students with tuition and academic support grants, offering opportunities to participate in company-led research and engage in international exchange activities.

(D) Operational status

As of 2024, South Korea's conditional employment contract majors are operated primarily by Samsung Electronics and SK Hynix, apart from the SMEs participating in the SME Contract Major Program. Together, these two companies operate undergraduate and graduate semiconductor contract majors across 12 departments at 10 universities, 8 of which were newly established in 2022.

Partner Companies	Established	Educational Institution	Department Name	Degree	Remarks
Samsung Electronics	2006	Sungkyunkwan University	Department of Semiconductor System Engineering	Bachelor	
	2021	Yonsei University	Department of System Semiconductor Engineering	Bachelor	
	2022	Korea Advanced Institute of Science and Technology	Department of Semiconductor System Engineering	Bachelor	
	2023	Yonsei University Graduate School	Department of System Semiconductor Engineering	Master/Doctoral	Established in 2021 as an undergraduate program, subsequently expanded to include graduate studies
	2023	Pohang University of Science and Technology	Department of Semiconductor Engineering	Bachelor	
	2024	Gwangju Institute of Science and Technology	Department of Semiconductor Engineering	Bachelor/Master	Bachelor/Master 5-Year Integrated Program
	2024	Daegu Institute of Science and Technology	Department of Semiconductor Engineering	Bachelor/Master	Bachelor/Master 5-Year Integrated Program
	2024	Ulsan National Institute of Science and Technology	Department of Semiconductor Engineering	Bachelor/Master	Bachelor/Master 5-Year Integrated Program
SK Hynix	2009	Korea University Graduate School	Department of Semiconductor System Engineering	Master/Doctoral	In 2015 Department name changed from Nano Semiconductor Engineering to Semiconductor Systems Engineering
	2021	Korea University	Department of Semiconductor Engineering	Bachelor	
	2023	Sogang University	Department of System Semiconductor Engineering	Bachelor	
	2023	Hanyang University	Department of Semiconductor Engineering	Bachelor	

3.4.3 Entry Talent Development Program for Partner Companies

(1) Specialized Leading University Support Program for New Industrial Fields (2021–)

Business Overview	-A program implemented by the Ministry of Education to support specialized universities in nine newly designated industrial fields, aimed at fostering sustainable development of specialized technical talent. -Implementation began in 2021, additional selection of support targets in 2023, and commencement of the second phase of the project in 2024.		
Business Goal	To designate specialized new industrial fields for each participating university and cultivate the technical talent required by regional industries through structured, field-specific talent development initiatives.		
Administrative Agency	Education Department	Target Talent	Entry-Level
Project Period	3 years in principle; however, 1 year for additional selections (3 years for 2021 and 2024 selections; 1 year for 2023 selection).	**Support Scale**	Support scale varies by project type. For semiconductor-related programs, funding is approximately 1 billion KRW per institution per year as of 2024. Both standalone college-led and polytechnic collaboration-led types exist; however, all 3 institutions selected for semiconductor projects operate as standalone programs.

(A) Background for Promotion

In response to the Fourth Industrial Revolution, demand has grown for specialized professionals capable of adapting to changes in emerging industrial fields and contributing to balanced regional development. To address this, the government promotes specialized universities in these new industrial fields as hub institutions for cultivating highly skilled technical talent. By providing targeted support, the policy aims to strengthen collaboration between

universities, regional industries, and the broader industrial sector.

(B) Implementation Frameworks

The Specialized Leading Universities for New Industries Support Project is supervised by the Ministry of Education, while the National Research Foundation of Korea manages and operates the project. To promote balanced regional development, participating universities are selected separately for metropolitan and non-metropolitan areas. Each selected institution establishes specialized educational systems in its designated industrial field and collaborates with regional industries to develop and operate curricula aligned with industrial needs.

Institution Name	Responsibilities	Role Details
Ministry of Education	Business Oversight	Overall project management and formulation of basic plans
Korea Foundation for Korean Studies	Business Operation and Management.	· Selection of Supported Universities and Determination of Support Amounts (for the first selection in 2021, set a standard of four to five universities within the metropolitan area and seven to eight universities outside the metropolitan area) · Project management and outcome evaluation
Supported Universities	Educational Model Curriculum Development and Management	· Establishment of a specialized leading university model related systems and infrastructure. · Development of educational curricula in collaboration with regional, specialized strategic fields, considering industry trends and needs

(C) Educational Overview

Support is provided to specialized universities capable of establishing and operating new academic departments in emerging industrial fields that meet the needs of regional industries. Selected universities are expected to build the necessary infrastructure for specialized education in these new fields, develop and operate industry-aligned curricula, and expand student access to these programs.

Educational Institutions	Vocational schools and universities capable of establishing and operating new departments in emerging industrial fields
Target Students	Students enrolled in specialized field departments, as well as students from other majors and other vocational schools
Operational Methods	· Selection of specialized fields based on regional industries, departmental characteristics, etc. (Each university selects specialized emerging industrial fields after analyzing regional industries, regional specialized strategic fields, characteristics of nearby companies, and departmental characteristics) · Establishment of specialized talent development infrastructure for new industrial fields (reorganization of existing curricula and development of new ones, including establishment/modification of new industrial field departments and launch of interdisciplinary majors) · Development of curricula to strengthen practical skills and job placement collaboration (operation of curricula to enhance practical abilities through industry-academia cooperation programs and field training, while promoting career guidance and company matching) · Expanding talent development scale by improving access to new industry curricula (allowing students from other majors and other schools to participate in new industry. The department has introduced a series of courses to expand the talent development program, with a focus on new industry fields.

(D) Current Operational Status.

In the initial phase of the 2021 initiative, two schools were selected among 12 applicants in the semiconductor field. By 2023, two additional schools were added to the program. In the second phase of the 2024 initiative, three schools were selected among 17 applicants in the semiconductor field.

Selection Year	Supporting Organization	Education Field
2021	Kyungnam College of Information & Technology	Next-Generation Semiconductor Manufacturing and Processes and Equipment Operation/Management
	Daelim University College	Next-Generation Semiconductor Manufacturing Processes and Equipment
2023	Osan University	Neuromorphic Chip Manufacturing Equipment
	Chosun College of Science and Technology	Next-Generation Semiconductor Back-End Processes
2024	Daelim University	Next-Generation Semiconductor Manufacturing Processes and Equipment
	Osan University	Neuromorphic Chip Manufacturing Equipment
	Chosun College of Science and Technology	Next-Generation Semiconductor Back-End Processes

(2) SME Contract Department with Employment Conditions (2023–)

Business Overview	The Ministry of SMEs and Startups operates a program that supports educational institutions providing training for both current and prospective employees of SMEs, as well as students enrolled in contracted degree programs. The program consists of two types: employment-conditional and retraining. The first employment-conditional contracted degree program in the semiconductor field was established in 2023. The employment-conditional program supports talent development and recruitment collaboration for SMEs, while the retraining program supports degree program operation for individuals currently employed at SMEs.		
Business Objectives	To alleviate recruitment difficulties and enhance the competitiveness of semiconductor-related SMEs by supporting talent development and recruitment collaboration.		
Business History	- 2010: Eleven re-education contract programs at master's level established - 2011: Expansion to include associate and bachelor's degree programs - 2023: Establishment of the first employment-conditional contract program for SMEs in the semiconductor field		
Administrative Authority	Ministry of SMEs and Startups	Target Talent	Entry-level
Support Details	For Universities: Contract Program Operating Expenses For Students: Tuition Fees (For Contract Programs with Employment Conditions, the Government Covers Full Tuition)	**Support Scale**	Approximately 35 million KRW per semester is allocated for program operating expenses, with selection evaluations conducted every three years.

(A) Background

Since the program's inception in 2010, only retraining-type contract programs supporting the retraining of employees at SMEs in the semiconductor field had been established. However, following the announcement of the "Semiconductor-Related Human Resources Development Plan" in 2022, employment-condition contract programs were established for the first time in the semiconductor industry to support SMEs in talent development and secure new hires.

(B) Implementation Framework

The SME Contract Department with Employment Conditions is overseen by the Ministry of SMEs and Startups. It provides financial support to students enrolled in selected educational institutions and programs designated by the Korean SMEs and Startups Agency. The selected institutions recruit participating SMEs and students, establish tripartite agreements, and operate degree programs that reflect industry needs.

Institution Name	Responsibilities	Role Details
Ministry of SMEs and Startups	Ministry of SMEs and Startups	· Formulation and implementation of the basic business plan · Approval of operational agreements by contracted disciplinary management deliberation committee
Korea SMEs and Startups Agency	Selection Evaluation	· On-site investigation and selection evaluation of universities applying for the business
Educational Institutions	Project Planning Conclusion of Tripartite Agreements -Education Authority	· After submitting the business application, create the application guidelines and recruit small and medium-sized enterprises wishing to participate · After securing students and companies, oversee the conclusion of tripartite contracts. between the university, companies, and students through mutual matching · Operate degree programs reflecting industry needs

(C) Educational Overview

The objective of this initiative is to strengthen employment partnerships between small and medium-sized enterprises (SMEs) and graduates of contracted department programs. Supported universities assume primary responsibility for establishing agreements with participating companies and managing educational operations under government supervision. In exchange for tuition assistance, students enrolled in these programs are required to work for their partner companies for a specified period after graduation.

Educational Institutions	Universities with the capacity to deliver educational programs and collaborate with industry partners in ways that reflect the needs of the semiconductor industry.
Target Students	Students enrolled in contracted departments
Operational Methods	Implementation of degree programs following the conclusion of a tripartite agreement among the university, company, and student. Development of educational curricula and implementation of field training through university-company collaboration After degree completion, supported students must work at the contracted company for the period specified in the agreement

(D) Operational Status

The Semiconductor Field Conditional SME Contract Program, established in 2023, is currently the only semiconductor software department operating at Baewha Women's University. It offers a two-year daytime program and, as of 2024, has agreements with five small and medium-sized enterprises.

Year Established	Educational Institution	Department	Partner Companies (2024)
2023	Baewha Women's University	Semiconductor Software Department	WISEWIRES Tbell Infogram Comes Inc. LUKEN Technologies Co., Ltd

(3) Vocational High School Recruitment Collaboration-Based Job Training Program Support Project (2023–)

Business Overview	・A program by the Ministry of Education to support educational institutions capable of operating customized job training programs tailored to individual companies for vocational high school graduates seeking employment. ・First implemented in 2022, but support for the semiconductor sector began in 2023.		
Business Objectives	・To address labor shortages and employment challenges by establishing and operating structured training programs that align the skills and competencies of job-seeking graduates with the specific roles and requirements of participating companies.		
Administrative Authority	Ministry of Education	Target Talent	Entry-level
Support Details	1 year	Support Scale	As of 2024, up to 400 million KRW per institution; support rates vary by education type

(A) Background for Promotion

In recent years, enrollment in vocational high schools has declined, while enrollment in universities has increased among graduates. This trend has created a growing need for policy-driven employment support for these graduates. Consequently, 41 specialized curricula were established in 2022, expanding to 45 curricula in 2023 with the addition of a semiconductor field. As demand for hands-on specialized talent in semiconductor manufacturing continues to grow, the program aims to cultivate individuals who can work in production engineering and maintenance roles within the semiconductor industry.

(B) Promotion System

The Ministry of Education oversees the Vocational High School Recruitment-Linked Job-Specific Curriculum Support Project, while the Korea Chamber of Commerce and Industry (KCCI) manages its operations. The KCCI is responsible for selecting participating institutions that receive training-cost support from the Ministry of Education. These institutions then operate curricula tailored to corporate needs.

Institution Name	Responsibilities	Role Details
Ministry of Education	Overall Project Management	Formulation and promotion of basic project plans
Korea Chamber of Commerce and Industry	Commissioned Implementation of Projects	Project solicitation, agreement execution, project cost settlement, and performance evaluation
Participating Educational Institutions	Education Implementation	Project applications, educational operations, student support and recruitment collaboration

(C) Educational Overview

This program provides support to specialized colleges and employment-related educational institutions that offer vocational high-school students hands-on training in semiconductor production and maintenance. Selected institutions that receive government funding are responsible for securing corporate partners and managing educational operations. Participants receive tuition assistance and training allowances through national funds.

Educational Institutions	Educational institutions and companies capable of operating specialized semiconductor education and implementing recruitment partnerships
Target Students	Third-year vocational high school students and job seekers within one year of graduation (maximum capacity of 25 students per course)
Program Operation Methods	-Provide practical training on semiconductor manufacturing processes and equipment maintenance (at least 30% of the overall training must consist of practical courses) -Training period: 1 to 4 months, comprising 140 to 520 hours -Educational institutions must secure employment for participating students (institutions must secure partner companies at the time of program application) -Full tuition support for trainees provided by national funds, with additional support such as training allowances

(D) Current Operational Status.

In 2023, 35 institutions offered 44 employment-linked vocational courses, of which 10 institutions and 11 courses were related to the semiconductor field. In 2024, 29 institutions operated 41 courses, including six institutions and seven courses in the semiconductor field.

Selection Year	Selected Institutions	Curriculum
2023	Kyungnam College of Information & Technology	Semiconductor Device and Equipment Manufacturing Element Technology Education Program
	Taegu Science University	Semiconductor Manufacturing Process
	Daelim University College	Semiconductor Manufacturing Equipment Maintenance Training Program Semiconductor Production Operator Training Program
	Doowon University of Technology	Semiconductor Equipment Maintenance and Control Process
	Korea Polytechnics	Semiconductor Manufacturing Process Semiconductor Manufacturing Equipment Maintenance Specialist Training Program
	Korea Chamber of Commerce and Industry Gwangju Talents Development Institute	Semiconductor Production Specialist Development
	Korea Chamber of Commerce and Industry Incheon Talents Development Institute	Semiconductor Production Specialist Development
	Korea Chamber of Commerce and Industry Chungnam Talents Development Institute	Semiconductor Production Specialist Development
	Korea Chamber of Commerce and Industry Seoul Technical Education Center	Semiconductor Production Specialist Development
	LetuiN Edu Co., Ltd.	Practical Optimization Project Course for Semiconductor Manufacturing Equipment CS Engineers
2024	Taegu Science University	Semiconductor Manufacturing Process
	Korea Chamber of Commerce and Industry Gwangju Talents Development Institute	Semiconductor Production Specialist Training Program
	Korea Chamber of Commerce and Industry Incheon Talents Development Institute	Semiconductor Job Recruitment Process (DB HiTek) Semiconductor Job Recruitment Process (STATS ChipPAC Korea)
	Doowon University of Technology	Semiconductor Manufacturing Equipment Maintenance and Control Process
	Thein	Semiconductor Manufacturing Equipment Maintenance and Control Engineer Training Program
	Korea Polytechnics	Semiconductor Manufacturing Process System Maintenance Specialist Training Program

(4) Work-Study Concurrent Program (Senior Industries Academy, 2023)

Business Overview	A program by the Ministry of Employment and Labor to support curriculum management for education related to strengthening on-the-job experience for bachelor's and specialized bachelor's degree holders in cutting-edge industrial fields.		
Business Objectives	To promote collaboration between companies and schools in advanced industries, fostering specialized professionals through field-training-centered education and addressing imbalances in labor supply and demand.		
Administrative Agency	Ministry of Employment and Labor	**Target Talent**	Entry-level and intermediate-level
Project Period	3 years	**Support Scale**	Funding limits are determined based on the educational management structure and the number of training participants (up to a maximum of 1 billion KRW).

(A) Background for Promotion

With the rapid growth of cutting-edge industries, the need for both quantitative and qualitative improvements in related specialized talent has increased. To address this demand, the government aims to support collaborative education management between universities and companies to provide students with field experience and create opportunities for recruitment and collaboration in advanced industries.

(B) Implementation Structure

The Work-Study Concurrent Program is overseen by the Ministry of Employment and Labor, with the Human Resources Development Service of Korea executing the program. The Human Resources Development Service of Korea is responsible for evaluating eligible educational institutions. selected by the Ministry and supports them in developing training courses, planning operations, and recruiting participating students and corporate partners.

Organization Name	Responsibilities	Role Details
Ministry of Employment and Labor	Business Summary	Implementation summary of concurrent work and study programs Selection of support recipients and outcome evaluation
Human Resources Development Service of Korea	Business Promotion	Recruitment and selection of educational institutions Support for training course development and review
Educational Institutions	Education Implementation	Planning and operation of training courses Recruitment of partner companies and participating students

(C) Educational Overview

Support is provided to specialized colleges and general universities capable of implementing field-based education through specialized courses in cutting-edge industries in collaboration with partner companies. Universities receiving government funding require prospective graduates to complete one year of study: first through on-campus coursework covering NCS-designated major subjects, followed by field-based training at partner companies.

Educational Institutions	Specialized colleges and general universities capable of operating work-study programs in cutting-edge fields
Target Students	Final-year students at specialized colleges and general universities
Program Outline	· Curriculum structured for 600 to 800 hours over one year (minimum 600 hours for NCS Level 3 education; minimum 800 hours for Levels 4 to 5) · Universities and companies collaborate to operate field-optimized curricula (Universities implement NCS-designated major courses as Off-JT education, followed by OJT field training at companies) · Provide support funds and wages to students completing training (Includes training support funds upon completing Off-JT training, wages for work during the OJT period, and scholarships for social advancement support)

(D) Operational Status

As of 2024, two vocational schools and four general universities are implementing the Work-Study Concurrent Program curriculum.

Category	Selected Institutions	Curriculum
Vocational School	Daelim University College	Semiconductor Manufacturing Equipment Assembly
	Pusan National University	Semiconductor Manufacturing Operations
General University	Incheon University	Development of Semiconductor Manufacturing Equipment
	Daegu University	Development of Semiconductor Manufacturing Equipment
	Inha University	Semiconductor Design
	Mingzhi University	Semiconductor Design, Semiconductor Manufacturing Equipment Development

3.4.4 Process-Specialized Intermediate-Level Talent Training Project

(1) Semiconductor Major Track Program (2022–)

Business Overview	Ministry of Trade, Industry and Energy initiative to support the establishment and operation of specialized tracks in semiconductor design, materials, components, and equipment—reflecting industry needs—within university-industry consortiums		
Business Objectives	To develop and operate undergraduate major tracks based on industry demand, cultivate technical talent in the semiconductor sector, and enhance overall industrial competitiveness.		
Administrative Agency	Ministry of Trade, Industry and Energy	**Target Talent**	Intermediate
Business Period	Projects ending February 2025, with project duration varying by selection year -2022 selection criteria: 32 months -2023 selection criteria: 24 months	**Support Scale**	For the 2023 selection, project funding will be adjusted based on the annual budget scale of approximately 900 million KRW per university and the results of performance evaluations.

(A) Background for Promotion

As the semiconductor industry continues to grow, the demand for intermediate-level talent is expected to increase sharply. However, semiconductor companies are experiencing growing difficulties in securing qualified personnel. Consequently, it has become increasingly urgent for universities to cultivate talent that meets industry demands and to provide stronger employment linkage support for graduates.

(B) Implementation Framework

The Semiconductor Major Track Program, initiated by the Ministry of Trade, Industry, and Energy, provides funding through the Korea Institute for Advancement of Technology to university consortia capable of operating semiconductor major tracks. These university-industry consortia, composed of participating universities and companies, design and operate semiconductor major tracks with government support.

Organization Name	Responsibilities	Role Details
Ministry of Trade, Industry and Energy	Business Oversight	Business Plan Formulation and Budget Management
Korea Institute for Advancement of Technology	Business Operation and Management	Business Planning, Evaluation, and Management
University Consortium	Establishment and Operation of Specialized Tracks	Consortium-participating universities (recruitment of companies to assist in operating specialized tracks; development and operation of curricula based on industry needs.) Consortium-participating companies (participation in industry-academia projects; proposal and communication of industry demands)

(C) Educational Overview

This initiative supports general universities forming consortia with companies in the semiconductor design, materials,

components, and equipment sectors. Selected universities and companies within these consortia jointly develop and implement semiconductor education programs tailored to industrial needs. Students who complete a specialized track can leverage university career-support systems and semiconductor-track degrees to secure employment in the industry.

Educational Institutions	General universities operating or planning universities related to the semiconductor field (When applying for the project, choose from either ① semiconductor design or ② semiconductor materials, components, and equipment fields)
Target Students	Undergraduate students in their 3rd or 4th year planning to work for semiconductor companies (Newly select 40 students per year per university)
Operational Methods	▪Development and operation of industry-demand-based curricula (Develop systematic educational programs based on consortium member companies' needs) ▪Structure educational programs to expand students' field experience (Organize industry-academia collaboration projects enabling field experience as credit-linked courses) ▪Operation and coordination of employment support programs ▪Financial support and employment assistance for participating students (Participants receive scholarships and notation of semiconductor specialization track completion on their degree certificates)

(D) Current Operational Status.

In the fields of semiconductor design and semiconductor materials, components, and equipment, 30 institutions were selected in 2022 and five schools in 2023.

Selection Year	Selected Universities
2022	Gachon University, Kangnam University, Kyung Hee University, Kwangwoon University, Kookmin University, Kumoh National Institute of Technology, Dankook University, Daegu University, Dongguk University, Myongji University, Pukyong National University, Pusan National University, Sahmyook University, Sun Moon University, Sungkyunkwan University, Soongsil University, Asia University, Yonsei University, Ewha Womans University, Inje University, Inha University, Jeonbuk National University, Chung-Ang University, Cheongju University, Chungnam National University, Tech University of Korea, Hanyang University, Hanyang University ERICA, Hoseo University, Hongik University
2023	Kyonggi University, Sogang University, Seoul National University of Science and Technology, Ulsan University, Hanbat National University

(2) Semiconductor Specialized University Support Business (2023–)

Business Overview	An initiative by the Ministry of Education to designate and support specialized fields based on the capabilities and strengths of individual universities and university consortia. This initiative operates under two types: - Standalone type: Each university independently promotes talent development. - Collaborative type: Talent development is pursued through collaborative frameworks that involve the joint utilization of resources among multiple universities and the conferral of multiple degrees.		
Business Goals	To stably cultivate excellent intermediate-level talent through the selection of specialized universities in the semiconductor field.		
Administrative Agency	Ministry of Education	Target Talent	Intermediate-level
Project Period	4 years	Support Scale	As of 2024, differential funding is provided within a budget of 43 billion KRW to eight schools or consortia, varying by project type. Each recipient receives between approximately 4.5 billion KRW and 8.5 billion KRW, depending on evaluation results and institutional capacity.

(A) Background for Promotion

The University Support Program for Semiconductor Specialization was implemented as a core initiative for undergraduate-level talent development following the announcement of the "Semiconductor-Related Human Resources Development Plan" in 2022. Previously, universities primarily focused on cultivating intermediate-level talent, which remains the most in-demand category in the industry. However, the projected rapid increase in demand for senior talent necessitated expanding the foundation for developing high-level specialists. Accordingly, this program was launched to promote balanced growth across the semiconductor sector by encouraging each university to specialize in a specific field, thereby establishing a foundation for the stable production of intermediate-level talent across diverse areas.

(B) Implementation Structure

The Ministry of Education oversees the Semiconductor Specialization University Support Project. The Korea Institute for Advancement of Technology (KIAT) is responsible for project operations and management, formulating implementation plans, selecting and evaluating participating universities, and conducting post-implementation outcome evaluations. Educational institutions fulfill the following roles: ① Formulating specific training objectives and plans, ② Operating specialized education curricula, ③ Securing excellent faculty members, including those with industry experience, ④ Improving the undergraduate-degree system, and ⑤ Supporting student employment and further education.

Institution Name	Responsibilities	Role Details
Ministry of Education	Overall Business Management	・Formulation and promotion of the basic project plan ・Execution and management of government subsidies
Korea Institute for Advancement of Technology	Business Operation and Management	・Formulation of project implementation plans and conducting selection evaluations ・Operation of the Semiconductor Talents Development Collaborative Support Center for Continuous Monitoring of Project Performance ・Analysis and evaluation of outcomes
Universities	Formulation and implementation of educational plans	・Establishment of educational promotion systems and operation of specialized curricula ・Development and improvement of educational environments and corporate collaboration ・Support for student employment and further education

(C) Educational Overview

This initiative supports universities with strengths in specific semiconductor fields (individual universities), and university consortia seeking collaborative growth (consortium-based universities). Selection was conducted separately for metropolitan and non-metropolitan areas. Supported institutions are tasked with establishing semiconductor-specialized departments and advancing specialized education, and inter-university cooperation with government support.

Educational Institutions	・Universities (individual) and university consortia (collaborative) with strengths in specialized fields for Semiconductor Human Resource Development ・Specialized fields: ① Circuits and Systems, ② Device and Process Development, ③ Materials, Components, and Equipment, ④ Testing and Packaging, etc.
Target Students	-New students in relevant departments and students aspiring to collaborative majors
Operational Approach	・Establishment of an educational framework for specialized fields (Establish and operate semiconductor-related majors (primary majors, interdisciplinary majors) to provide foundational and interdisciplinary semiconductor education) ・Operation of senior education programs related to specialized fields (When establishing specialized field-related curricula, offering at least 6 credits of senior education programs is mandatory) ・Promotion of collaboration based on each university's specialized field (In cases of multi-university consortiums pursuing mutual growth, establish joint degree programs for each university's specialized field to enhance operational efficiency)

(D) Current Operational Status.

In 2023, eight entities were selected (five standalone and three collaborative). In 2024, nine entities were selected (three standalone and five collaborative). For the 2024 additional selection, quantitative indicators regarding the practical training environment in specialized fields were added as evaluation metrics. This enhancement aimed to strengthen the practical (process-specific) skills of trained personnel and enhance the effectiveness of the project.

Selection Year	Type	Region	University	Specialized Field
2023	Independent Type	Metropolitan Area	Seoul National University	Circuits/Systems, Devices/Processes
			Sungkyunkwan University	Next-Generation Semiconductors
		Non-Metropolitan Areas	Kyungpook National University	Circuits/Systems, Devices/Processes, Materials/Components/Equipment
			Korea University Sejong Campus	Senior Semiconductor Equipment
			Pusan National University	Automotive Semiconductors
	Collaborative	Metropolitan Area	Myongji University - Hoseo University Alliance	Materials, Components, Equipment, Packaging
		Non-Metropolitan Areas	Jeonbuk University - Jeonnam University Alliance	Next-Generation Mobility Semiconductors
			Chungnam National University - Chungbuk National University - Korea Institute of Technology and Education Alliance	System Semiconductors, Foundry Semiconductors
2024	Independent Type	Metropolitan Area	Gachon University	Circuits/Systems, Devices/Processes
			Sogang University	Circuits/Systems, Devices/Processes
			Yonsei University	Circuits/Systems, Devices/Processes
	Collaborative	Metropolitan Area	Korea University - Inje University Alliance	Next-Generation AI Semiconductors
			Asia University - Hanbat University Alliance	Circuits/Systems, Devices/Processes, Packaging
			Inha University - Kangwon National University Alliance	Chiplet Semiconductors
			Tech University of Korea - Kongju National University Alliance	Senior Semiconductor Measurement/Analysis/Inspection
		Non-Metropolitan Areas	Gyeongsang National University - Pukyong National University Alliance	Testing and Packaging
			Kumoh National Institute of Technology - Yeungnam University Alliance	Materials/Components/Equipment

(3) Senior Industry Talent Bootcamp Project (2023–)

Business Overview	Ministry of Education Project to support the development and operation of university industry-academia collaboration intensive short-term education programs First implemented in 2023, primarily in the semiconductor field, with support areas expanded to national senior strategic industries in 2024		
Business Objectives	To respond to the rapidly increasing demand for skilled professionals by swift talent supply in high-priority industrial fields, including semiconductors		
Administrative Agency	Ministry of Education	Target Talent	Intermediate-level talent (and entry-level talent)
Project Period	5 years	Support Scale	The 2024 budget averages 1.5 billion KRW per institution annually. Budget allocation per university is based on talent development plans.

(A) Background for Promotion

The demand for talent in cutting-edge fields is rapidly increasing. However, meeting this demand has proven difficult under the current supplier-centric approach to talent development. To address this challenge, the government aims to rapidly supply job-ready professionals by supporting universities and companies in the joint development and

operation of short-term, intensive education programs.

(B) Implementation Structure

The Senior Industry Talent Bootcamp is a Ministry of Education initiative, with the Korea Institute for Advancement of Technology (KIAT) responsible for project management and operations. Participating universities in collaboration with industry partners, form Bootcamp Consortia to jointly design and implement curricula that reflect industrial needs and promote field-oriented learning.

Organization Name	Responsibilities	Role Details
Ministry of Education	Business Oversight	Overall project management and implementation plan development
Korea Institute for Advancement of Technology	Business Operation and Management	Project planning, evaluation, and management
University	Bootcamp Project Group Composition and Operation Curriculum Development and Operation	Participating company recruitment and collaborative planning Development and operation of bootcamp curriculum through collaboration with companies

(C) Educational Overview of the Senior Industry Talent Development Boot Program

This project supports universities and specialized colleges that are capable of operating intensive short-term semiconductor-related educational programs in collaboration with companies. Participating institutions are responsible for recruiting partner companies and jointly implementing the developed short-term educational programs for at least 100 students annually, with the goal of rapidly training a large number of semiconductor-related professionals.

Educational Institutions	Universities and vocational schools that have established a foundation for developing talents for senior industries
Target Students	Students enrolled at the affiliated university and other universities (students from other universities may participate within 20% of the training target number for each university)
Management Methods	• Train approximately 100 to 300 people per year per university • Establish a certification (microdegree) system for students participating in boot camps • Encourage active corporate participation in curriculum management (reflect corporate demand and job competencies in the educational process, hire industry expert instructors) • Conduct subject-based education linked to regular courses and immersion-based education centered on practical training in parallel (subject-based education refers to regular courses partially developed in collaboration with partner companies; immersion-based education refers to practical training-centered courses developed and operated in collaboration with partner companies)

(D) Current Status of Support Organizations in the Semiconductor Field

In the semiconductor field, 10 institutions were selected in 2023. By 2024, a total of 32 institutions were selected across five senior industrial fields, including 18 in the semiconductor field.

Selection Year	Selected Universities
2023	Gachon University, Gangneung-Wonju National University, Gyeonggi University of Science and Technology, Dankook University, Dongyang Mirae University, Doowon Technical University, Osan University, Ulsan College, Tech University of Korea, and Korea Maritime and Ocean University
2024	Kyonggi University, Kyungnam University, Kyungil University, Gumi University, Daegu University, Daelim University College, Dongguk University, Dong-eui University, Sun Moon University, Woosong University, Inha Technical College, Cheongju University, Pyeongtaek University, Hankyong National University, Hankuk University of Foreign Studies, Hanyang University, Hanyang University ERICA Campus, and Hongik University

3.4.5 Senior Talent Development Business for Technology Research

(1) Semiconductor Specialized Graduate School Support Project (2023–)

Business Overview	A program by the Ministry of Trade, Industry, and Energy to support graduate schools capable of establishing and operating semiconductor specialized programs with funding for talent expenses, curriculum operation costs, etc.		
Business Objective	To establish a system for cultivating master's and doctoral-level semiconductor professionals who meet industry demand.		
Administrative Agency	Ministry of Trade, Industry and Energy	Target Talent	Senior
Program Duration	5 years	Support Scale	Approximately 3 billion KRW per university per year, totaling about 15 billion KRW over 5 years

(A) Background for Promotion

Semiconductors are critical assets essential to national security and technological leadership. However, the number of master's and doctoral graduates leading technological innovations in the semiconductor field has steadily declined. This downward trend underscored the need for large-scale, government-led support measures.

(B) Implementation Structure

The Semiconductor-Specialized Graduate School Support Project is a part of the Ministry of Trade, Industry, and Energy initiative. The Korea Institute for Advancement of Technology (KIAT) is responsible for project operation and management. Educational institutions are required to establish specialized graduate schools, build educational environments, and develop and operate curricula aligned with industry needs

Organization Name	Responsibilities	Role Details
Ministry of Trade, Industry and Energy	Business Oversight	Overall project management and implementation plan formulation
Korea Institute for Advancement of Technology	Business Operation and Management	Project planning, evaluation, and management
University	Establishment of Graduate Schools and Operation of Educational Programs	·Establishment of graduate schools for semiconductor specialization ·Establishment of a semiconductor education environment ·Development and operation of industry-demanded curricula

(C) Educational Overview

This project supports universities capable of establishing and operating specialized graduate schools dedicated to semiconductor-related technological research. Participating universities operate advanced curricula focused on core technologies within specialized fields, survey the needs of companies belonging to the General Management Committee, and reflect these needs in their curricula.

Educational Institutions	Universities that meet all eligibility requirements, including plans to establish a semiconductor-graduate school, operate master's and doctoral degree programs, secure full-time faculty and enrollment quotas, and establish an appropriate educational environment. Specialized Fields: ① Circuits and Systems, ② Device and Process Development, ③ Materials, Components, and Equipment, ④ Testing and Packaging
Target Students	Master's program, integrated Master's/Doctoral program students
Operational Methods	Development and operation of senior education programs focused on core technologies within specialized fields Operation of educational programs reflecting industry needs (The university operates a comprehensive management committee with corporate participation. After identifying industry needs, it incorporates them into the design of educational programs and industry-academia projects.)

(D) Current Operational Status

Sungkyunkwan University, Ulsan National Institute of Science and Technology (UNIST), and Korea Advanced Institute of Science and Technology (KAIST) were selected in 2023. Kyungpook National University, Pohang University of Science and Technology (POSTECH), and Korea University were selected in 2024.

Selection Year	Institution	Specialized Fields
2023	Sungkyunkwan University	Circuits & Systems, Device & Process Development, Materials, Components & Equipment, Test & Packaging
	UNIST	Materials, Components, and Equipment
	KAIST	Device and Process Development, Materials, Components, and Equipment, Test, and Packaging
2024	Kyungpook National University	Device and Process Development, Materials, Components, and Equipment
	POSTECH	Circuits and Systems, Materials, Components, and Equipment
	Korea University	Testing and Packaging

(2) Artificial Intelligence Semiconductor Graduate School Support Business (2023–)

Business Overview	Ministry of Science and ICT initiative to support graduate schools capable of establishing and operating artificial intelligence semiconductor programs with funding for talent expenses, curriculum operation costs, etc.		
Business Goal	To cultivate 500 world-class senior professionals specializing in AI semiconductor design and AI/software.		
Administrative Agency	Ministry of Science and ICT	Target Talent	Senior
Business Period	6-year project	Support Scale	Approximately 3 billion KRW per university per year, totaling about 16.4 billion KRW over six years

(A) Background for Promotion

As artificial intelligence (AI) becomes integrated across all industries, the need to cultivate highly skilled professionals capable of securing and developing cutting-edge AI semiconductor technologies has grown significantly. Following the Ministry of Science and ICT's 2022 announcement of the "Artificial Intelligence Semiconductor Industry Growth Support Measures," it became necessary to implement follow-up initiatives focused on specialized talent development.

(B) Implementation Framework

The AI Semiconductor Graduate School Support Program is an initiative of the Ministry of Science and ICT. Participating universities are tasked with establishing AI semiconductor graduate schools and developing and operating educational curricula that support the creation of cutting-edge AI semiconductor technologies.

Organization Name	Responsibilities	Role Details
Ministry of Science and ICT	Business Oversight	Planning and implementation of talent development initiatives based on the "Artificial Intelligence Semiconductor Industry Growth Support Measures"
University	Establishment of Graduate Schools and Operation of Educational Programs	Establishment of an Artificial Intelligence semiconductor graduate school Establishment of AI semiconductor education environment Development and operation of industry-academia collaborative curricula

(C) Overview of AI Semiconductor Graduate School Education

This initiative supports universities capable of establishing and operating AI semiconductor graduate schools. Participating universities implement a “Senior (Highly Specialized) Education Program” to cultivate master’s and doctoral-level senior professionals in AI semiconductor design and artificial intelligence software. They enhance students’ competencies through collaboration with domestic companies and overseas universities in these fields.

Educational Institutions	Universities that meet requirements such as establishing (planned) an AI semiconductor graduate school, operating master's and doctoral degree programs, securing full-time faculty and enrollment quotas, and building educational environments
Target Students	Master's program, doctoral program, and integrated master's-doctoral program students
Operational Methods	・Securing AI semiconductor-related faculty and implementing education (Securing at least 7 full-time faculty members, including professors, associate professors, and assistant professors, in fields such as system software and AI semiconductor design) ・Implementation of senior education in AI semiconductor design and AI software-related fields (e.g., AI semiconductor circuit design projects applying deep learning, neuromorphic devices and systems, senior semiconductor theory) ・Promotion of industry-academia collaborative education (Amend university regulations regarding part-time faculty positions for industry experts; implement student startup support, etc.) ・Promoting joint education and research with leading overseas universities (Mandatory support for participation in overseas innovative education programs and joint research for at least 5 students per graduate school)

(D) Current Status of Support Institutions

In 2023, Seoul National University, KAIST, and Hanyang University were selected.

Selection Year	Institution Name	Field of Education
2023	Seoul National University	Deep Learning Fundamentals and Applied Software, Neural Network Lightweighting Research, etc.
	KAIST	Next-generation intelligent semiconductor technology development, core technology development for PIM AI semiconductors, application technology development for AI semiconductors, etc.
	Hanyang University	Ultra-low power consumption and neuromorphic technology development, etc.

3.4.6 Implications from Analysis of Talent Development Initiatives

South Korea's Semiconductor Human Resources Development initiatives initially focused on contract-based academic programs aimed at cultivating intermediate-level practical talent for manufacturing companies. In response to the growing demand for a more diverse workforce in the semiconductor industry, the government launched the "Semiconductor-Related Human Resources Development Plan" in 2022. Since then, the scope of initiatives has expanded to include the cultivation of entry-level talent focused on specific fields and senior talent centered on technical research. However, as illustrated in Figure 3-4, the current workforce development initiatives remain predominantly concentrated in the Seoul Metropolitan Area, which includes Seoul and Gyeonggi Do. This concentration stems from the proximity of these regions to the headquarters of South Korea's two major IDMs and the presence of a well-established educational infrastructure for workforce development. Consequently, as semiconductor industry investment expands into regional areas, a growing imbalance in workforce distribution has emerged. To address this issue, the government has expanded support programs to attract the necessary workforce to regions such as Ulsan and Gyeongsangbuk Do, where new semiconductor industrial complexes are being actively developed (see Table 3-8). Consequently, the formulation of future talent development policies will require continuous monitoring of regional talent supply and demand. Furthermore, consideration must be given to implementing talent development projects that are optimized for the needs of each region.

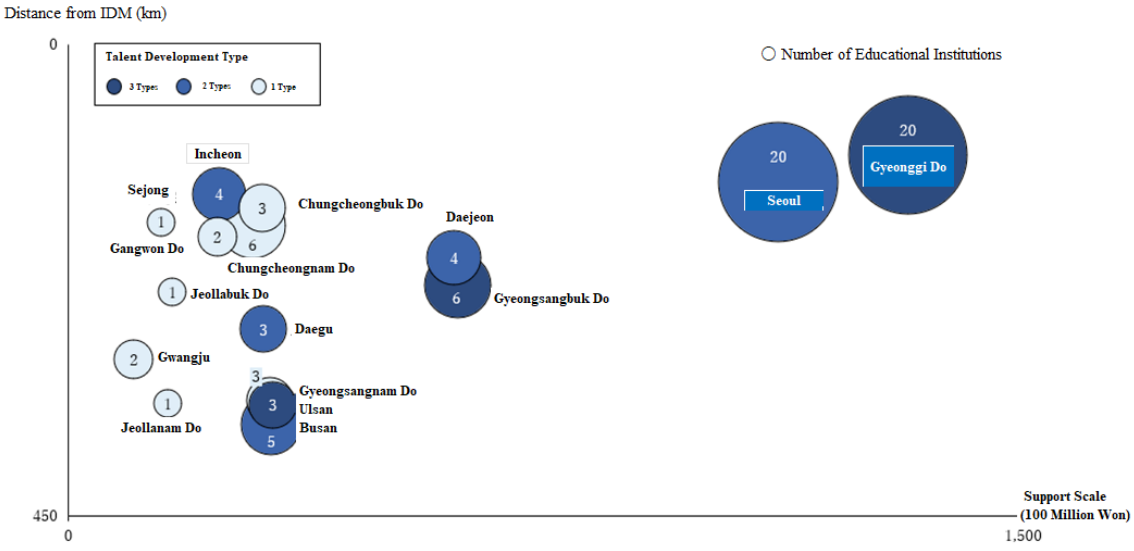


Figure 3-4 The Relationship Between Distance from South Korea's Two Major IDMs and Government Support Amount

Table 3-8 Current Status of Government Support by Region

Region	Support amount by talent type (100 million KRW)			Total Support Amount (100 million KRW)	Number of Educational Institutions
	Entry-Level	Intermediate	Senior		
Seoul	-	478	612	1,090	20
Busan	10	231	-	241	5
Incheon	75	78	-	153	4
Daegu	-	77	150	227	3
Dajeon	-	233	314	547	4
Gwangju	10	-	-	10	2
Ulsan	75	18	150	243	3
Sejong	-	56	-	56	1
Gyeonggi Do	285	872	150	1,307	20
Gangwon Do	-	150	-	150	2
Chungbuk Do	-	225	-	225	3
Chungnam Do	-	209	-	209	6
Jeollabuk Do	-	75	-	75	1
Jeollanam Do	-	67	-	67	1
Gyeongsangbuk Do	70	333	150	553	6
Geumosan Do	-	238	-	238	3

3.5 Industry Initiatives for Semiconductor Human Resources Development

As discussed in the previous section, there is growing recognition within the semiconductor industry that recent years have revealed limitations in talent development when relying solely on individual companies and educational institutions. Consequently, government support for semiconductor human resources development has diversified. However, major companies have proactively expanded their own talent development efforts beyond government policies. These corporate initiatives pursue a range of objectives, from strengthening internal capabilities to cultivating new talent at various professional levels. This section outlines the primary initiatives implemented by Korean semiconductor companies for talent development at the entry, intermediate, and senior levels (see Table 3-9).

Table 3-9 Industry Training Measures by Talent Level

Category	Entry Level	Intermediate	Senior
Initiatives	Promoting industry-academia collaboration with entry-level educational institutions	Operation of degree programs for members	Support for technology development at research institutions
Case Study	Hana Micron Inc. - Chungnam Semiconductor Meister High School establishes industry-academia collaboration reflecting industrial demand	Samsung Electronics Operation of bachelor's, master's, and doctoral programs at the Samsung Institute of Technology	Samsung Electronics and KAIST IDEC initiate Multi-project Wafer (MPW) Chip Production Support Project
Purpose	Demand-driven talent development Securing top talent	Strengthening internal talent capabilities	Supporting technological advancement Securing top talent

3.5.1 Entry-Level Talent Development Initiative: Hana Micron Promotes Industry-Academia Collaboration with Meister High Schools

Semiconductor companies in South Korea are implementing customized training programs for entry-level talent and promoting educational partnerships with institutions to secure a pool of highly skilled professionals. A prime example is the 2022 agreement between Hana Micron, a semiconductor back-end company headquartered in Asan, Chungcheongnam Do, and the Chungnam Semiconductor Meister High School (formerly Yesan Electronic Technical High School) in Yesan, Chungcheongnam Do. This agreement established a framework for industry-academia cooperation aligned with industrial needs.

The Chungnam Semiconductor Meister High School is a specialized institution that focuses on semiconductor back-end processes and equipment. Originally designated as an electronics specialty high school in 2001, it was selected as a semiconductor field at Meister High School in 2023. Its Semiconductor Convergence Department, currently the only department in operation, provides education focused on acquiring key semiconductor-related certifications, such as semiconductor equipment maintenance technicians and production automation technicians. Through this program, the school cultivates excellent entry-level professionals specializing in semiconductor back-end processes. Hana Micron actively promotes the immediate employment of outstanding graduates in high-demand fields by collaborating with the region’s semiconductor back-end specialized high schools to build a talent pipeline that complements government-supported projects. Through its industry–academia partnerships, the company delivers practical educational experiences by leveraging its corporate facilities and assisting in graduate job placement. It also fosters enhanced student-company engagement and on-the-job training opportunities. To strengthen the link between education and employment, the school conducts company visits and internship programs in the semiconductor process and equipment fields, including placements at Hana Micron, to enhance students’ understanding of and affinity for companies. Additionally, it reinforces recruitment collaboration with partner companies through job fairs and mentoring programs.

3.5.2 Intermediate-Level Talent Development Initiative: Samsung Electronics' Operation of Samsung Electronics University Degree Programs

As discussed in Chapter 2, intermediate-level talent, with a bachelor's degree, constitutes the largest proportion of the workforce in semiconductor companies. Korean semiconductor firms are expanding the operation of contract departments to cultivate and secure outstanding intermediate-level talent externally, while simultaneously enhancing the capabilities of their internal intermediate-level workforce. A notable example of internal capability enhancement is Samsung Electronics' operation of degree programs through Samsung Electronics University. As Korea's first corporate university, Samsung Electronics University received accreditation from the Ministry of Education for its Associate Degree Program in 2001, Bachelor's Degree Program in 2005, and Graduate School Program in 2011. The institution currently offers degree programs at all levels, from associate to doctoral programs. The undergraduate division features a Semiconductor Engineering major, while the graduate school offers a Semiconductor Display Engineering major.

The graduate school accepts applicants from all undergraduate majors, making it a valuable resource for enhancing semiconductor-related competencies among employees from diverse departments. It offers courses across a wide range of fields, including semiconductor design, process technology, equipment, and displays. Students receive advanced education in various semiconductor-related areas. Additionally, graduates of the cooperative program with Sungkyunkwan University receive degrees conferred by Sungkyunkwan University. Moreover, the campus's location within the Samsung Electronics headquarters offers a distinct advantage: the freedom to conduct education and research on security technologies that are not suitable for external disclosure. Building on these strengths, as of 2024, the program has produced 55 associate degree graduates, 539 bachelor's degree graduates, 605 master's degree graduates, and 98 doctoral degree graduates, contributing to the enhancement of intermediate-level talent capabilities.

3.5.3 Senior-Level Talent Development Initiatives: Samsung Electronics' Educational Support for the IC Design Education Center

Major Korean semiconductor companies are implementing contract-based graduate programs to attract top-tier talent. They also contribute to talent development by supporting technological R&D at research institutions, which indirectly fosters the flow of skilled researchers into their organizations. A prime example is Samsung Electronics' Multi-Project Wafer (MPW) chip production support program through its IC Design Education Center (IDEC). Since 2021, Samsung Electronics has provided the KAIST IC Design Education Center with access to semiconductor fabrication processes and related resources, enabling the practical implementation of system semiconductor designs. At IDEC, graduate students conduct research on system semiconductor chip design. However, due to the high cost of fabricating the designed schematics, only a limited number of students previously had the opportunity to experience the post-design fabrication process. To address this, Samsung Electronics has supported the enhancement of students' design capabilities by providing opportunities to fabricate approximately 600 chips across 15 batches over a six-year period.

Samsung Electronics' System LSI Business Division is responsible for system semiconductor design, while the Foundry Business Division oversees contract manufacturing. Consequently, developing cutting-edge system semiconductor technologies and securing top talent in this field remain critical priorities for the company. The Semiconductor Design Education Center collaborates with top universities such as KAIST, Hanyang University,

and Pusan National University to conduct education and research related to system semiconductor design. Samsung Electronics promotes the development of related technologies by supporting system semiconductor production at the Semiconductor Design Education Center. Concurrently, the company is broadening recruitment opportunities by establishing connections with the center's exceptional talent pool. In addition to this initiative, Samsung Electronics actively participates in job fairs and corporate forums organized by the IC Design Education Center, seeking to attract highly qualified candidates from universities without designated contract departments.

4 South Korea's Efforts to Secure Global Competitiveness

Since 2020, countries around the world have expanded their investments to secure leadership in the semiconductor industry. However, the supply of semiconductor talent remains insufficient, and if the current situation persists, a severe shortage of skilled talent is expected in the long term. According to data released by the South Korea Semiconductor Industry Association in 2021, a shortage of approximately 77,000 workers is projected by 2031. In Japan, materials published by the Japan Electronics and Information Technology Industries Association (JEITA) in 2024 anticipate a shortage of approximately 43,000 workers by 2034.

To address workforce shortages, governments and companies worldwide are promoting various initiatives to develop semiconductor human resources. When comparing the policies of South Korea and Taiwan in terms of (1) training strategies, (2) form of supports, and (3) promotion systems (Table 4-1), South Korea has (1) expanded the scope of training from a previous focus on intermediate-level, practice-oriented talent to encompass both entry-level and advanced-level talent since the establishment of the policy roadmap, the "Semiconductor-Related Human Resources Development Plan," in 2022. (2) Consequently, initiatives have diversified from managing contract-based academic programs supported primarily by voluntary investment from private enterprises to government-supported projects aimed at fostering talent for SMEs and advanced-level workforce training. (3) The promotion system has also expanded from being centered on the Ministry of Education to encompassing five ministries and agencies related to semiconductor human resource development, each implementing policy projects aligned with their respective roles.

In the case of Taiwan, (1) under the "National Talent Competitiveness Jumpstart Program," the country promotes the training of both domestic and foreign talent. (2) Under the leadership of the authorities, a large-scale fund centered on major semiconductor companies has been established to promote investment in strengthening industry-academia collaboration. (3) The promotion system is structured around two main pillars, each playing a distinct role. The Ministry of Education focuses on the quantitative expansion of non-doctoral human resources, while the National Science and Technology Council focuses on cultivating highly skilled doctoral-level human resources. Based on the analytical results presented in the previous section, we propose the future direction of Japan's semiconductor human resource development policy using insights derived from South Korea's initiatives to secure global competitiveness.

Table 4-1. Comparison of Semiconductor Human Resource Development Strategies in Korea and Taiwan

Classification	Korea	Taiwan
Demand and Supply Outlook	・A projected shortage of approximately 77,000 semiconductor workers by 2031.	・A projected shortage of 690,000 STEM workers by 2030 (including semiconductor workforce within STEM fields).
Training Strategy	・Since the establishment of the policy roadmap "Semiconductor-Related Human Resources Development Plan" in 2022, the target talent types have diversified from intermediate-level, practice-oriented talent for IDM to include both entry-level and advanced-level talent.	・Expansion to two pillars for Taiwanese and foreign talent, centered on the "National Talent Competitiveness Jumpstart Program" in 2024.
Form of Support	・Transition from contract-based academic programs supported by private-sector investment to government-supported initiatives since the formulation of the "Semiconductor-Related Human Resources Development Plan" in 2022, with expanded to include support policies optimized for SMEs and regional supply and demand.	・Establishment of large-scale funds led by authorities and centered on private enterprises, creation of specialized research institutes such as ITRI and TSRI, and continuous strengthening of industry–academia–government collaborative investments.
Promotion System	・Shift from a system centered on the Ministry of Education to one involving five ministries collaborating on semiconductor talent development, implementing role-specific training programs: - Ministry of Education; Ministry of Science and ICT; Ministry of Trade, Industry and Energy; Ministry of SMEs and Startups.	・Human resource development initiatives are promoted through two pillars: - the Ministry of Education (responsible for quantitative expansion of non-doctoral human resources) - the National Science and Technology Council (responsible for cultivating advanced human resources at the doctoral level).

4.1 Strengthening Public-Private Partnership Frameworks for Early Talent Acquisition and Retention

As described in Chapter 3, in South Korea, contract-based departments established and operated jointly by major IDMs, such as Samsung Electronics and SK Hynix, in cooperation with educational institutions, play a central role in developing semiconductor human resources. After companies support the costs necessary for department operations, design and operate the educational programs, and select talent on the condition of future employment, they provide financial support and practical training environments. This is expected to achieve a “two birds with one stone” effect, ensuring a stable workforce supply while cultivating personnel whose skills align with company needs. Indeed, Samsung Electronics, which established and operated the first contract-based semiconductor department—the Department of Semiconductor Systems Engineering at Sungkyunkwan University in 2006—reported that 86% of its graduates were employed by Samsung Electronics from 2006 through 2018.

The decision of such a major corporation to support operating costs for contract-based departments reflects the significant challenge companies face in cultivating and securing human resources with specialized semiconductor expertise.

Considering these corporate demands and challenges, the South Korean government enacted the Industrial Education Enhancement and Industry-Academia-Research Cooperation Act in 2023 to establish a foundation for contract-based departments. At enactment, the law explicitly stipulated that enterprises must bear at least 50% of the cost of establishing and operating these departments and strictly defined corporate responsibility and financial obligations in their operation. However, as the importance of systematic, national-level support for human resource

development policies has grown, direct government support has expanded to alleviate the burden on companies, accounting for regional balance and the development of small- and medium-sized enterprises. In 2023, the Act was amended to allow the corporate funding ratio to be less than 50% when establishing contract-based departments at universities outside the capital region. Furthermore, for SME employment contract-based departments introduced in 2023, the Ministry of SMEs and Startups, as the responsible authority, covers approximately 60–80% of the costs for currently operating programs, reducing the industry burden to 8–17% and alleviating the financial burden on SMEs through government support[30].

In Japan, efforts to rebuild the semiconductor industry base include not only attracting foreign companies such as TSMC to Kyushu but also establishing the domestic foundry company Rapidus in Chitose, Hokkaido, with the goal of achieving mass production. Under the leadership of these companies, joint educational programs with local universities and high schools are being established, and employees are posted as instructors to build human resource development frameworks. However, even if this framework quantitatively expands the pool of trained semiconductor professionals, there is no guarantee that they will join the semiconductor industry. There is also a risk that talent may migrate to foreign companies rather than domestic Japanese semiconductor firms. Indeed, a semiconductor workforce survey conducted in 2023 in Kyushu, a major semiconductor hub led by JASM, a company primarily funded by TSMC, revealed that only 2,400 (9%) science and engineering graduates in the region entered the semiconductor industry, indicating persistently low engagement. Thus, even if regional universities collaborate with local semiconductor companies to develop educational programs, the system cannot function effectively unless trained talent enters the semiconductor industry or partner companies. Therefore, it is necessary to introduce incentives similar to those in South Korea's contract-based departments to ensure that trained talent is reliably connected with cooperating companies. Furthermore, it is considered effective for the government to initially reduce the financial burden on companies, as the Korean government does for SMEs, and then gradually grant companies autonomy in establishing and operating the departments depending on the system's effectiveness.

4.2 Expanding the Development of Entry-, Intermediate-, and Advanced-level Talent and Revitalizing Industry Participation in Education

As confirmed in Chapter 3, since 2006, South Korea's semiconductor workforce development has focused on intermediate-level talent training through contract-based departments established by individual companies, primarily IDMs. However, since the formulation of the "Semiconductor-Related Human Resources Development Plan" in 2022, government-led human resource development initiatives have expanded to meet diverse industry demands, including entry- and advanced-level talent, as well as intermediate-level talent specialized in specific processes. For entry-level talent, under the leadership of the Ministry of SMEs and Startups, collaborative educational programs between specialized high schools (equivalent to Japan's colleges of technology) and specialized universities have been established. Additionally, practice-oriented, employment-linked, contract-based departments are being set up within specialized universities to promote human resource development. Simultaneously, efforts are also being made to train advanced-level talent through the establishment of specialized graduate schools.

30 Reference: Public data from the University Information Disclosure Center, managed by the Council of Korean University Education.

The South Korean government's formulation of these policies to expand the training of entry-level and advanced-level talent reflects the recognition that focusing solely on the intensive training of intermediate-level talent for IDMs cannot meet human resource demands across the entire industry. The semiconductor industry features multilayered stages within its value chain, including design, materials, components, equipment, front-end processes, and back-end processes. Even for large semiconductor IDMs, in-house production across the entire value chain is difficult, making it essential to secure regional supply networks. Therefore, balanced development of entry-level, intermediate-level, and advanced-level talent is necessary for each stage of semiconductor production. As demonstrated in Sections 1, 2, and 3, the remarkable growth of companies specializing in back-end processes, such as Hana Micron Inc., has increased human resources demand, leading to expanded policies for training personnel specialized in back-end processes.

In Japan, alongside fostering intermediate-level practical talent for large foundries, such as Rapidus and TSMC, a type-specific system for the supply and demand of human resources is being established. This includes training practical talent through the establishment of semiconductor majors at technical colleges and universities, as well as cultivating advanced-level technical research personnel through the Leading-edge Semiconductor Technology Center (LSTC) of the Technology Research Association. Thus, once an educational infrastructure for entry-, intermediate-, and advanced-level workforce development is established, it is necessary to build an ecosystem in which company-led workforce training is pursued simultaneously.

While institutional frameworks for developing all categories of human resources are being established in South Korea, companies are simultaneously implementing initiatives for entry and advanced-level workforce training programs. This stems from the time lag before talent developed through government policy flows into companies, which could potentially lead to a shortage in the total volume of trained workforce. Furthermore, within government policies, initiatives to enhance the practical skills of the trained workforce are being implemented by ensuring the autonomy of companies participating in educational programs. Recently, the development of semiconductor-related human resources across all levels—entry, intermediate, and advanced—has progressed in Japan. However, from the perspective of the timing of entry and the total volume of trained talent, it is necessary to operate company-led educational programs in parallel with government programs. Therefore, it is essential to build an ecosystem that promotes and revitalizes such initiatives.

4.3 Ensuring Balanced Support for Regional Hubs and Establishing Measures to Strengthen Inter-hub Collaboration

In South Korea, semiconductor clusters have primarily been developed in the capital region, where the production bases of major IDMs such as Samsung Electronics and SK Hynix are located. However, the need to ensure regional balance has increased to achieve more equitable development across the country. Consequently, plans are being developed to establish semiconductor hubs in various regions of South Korea. In addition, region-specific human resource development policies are being promoted, and managing coordination at the central government level has emerged as a challenge in strengthening interregional collaboration.

To promote balanced regional development through the semiconductor industry, the Korean Ministry of Education

has designated five regional national universities[31] as research hub universities, positioning Seoul National University as the central hub to support research, education, and training at each base. This policy aims to consolidate not only research functions but also human resource development functions. The establishment of each hub is scheduled for completion by 2026, and detailed operational plans are expected to be announced. In the semiconductor field, proposals are being considered to establish consultative bodies among semiconductor research institutes at universities to facilitate technological cooperation, joint research, personnel exchange, and the development of collaborative educational programs. However, discussions are currently limited to consultative bodies among hub universities in each region, and the establishment of consultative bodies or consortia that include enterprises has not yet been considered.

Meanwhile, in Japan, the "Project for the Establishment of Semiconductor Human Resource Development Hubs," promoted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) since 2025, is establishing semiconductor human resource development hubs nationwide to advance initiatives aimed at segmenting semiconductor-related industries and promoting balanced regional development. Under this project, hub universities collaborate with multiple universities in their regions to implement educational programs that reflect regional characteristics and the strengths of each university related to semiconductors. Simultaneously, through the LSTC, national-level infrastructure is being developed to train advanced research talent and lead technological innovation, thereby creating a human resource development system that ensures equity between national and regional levels.

In implementing the "Project for the Establishment of Semiconductor Human Resource Development Hubs," there is concern that if each university focuses solely on education and research within its specialized fields, balanced development across all sectors of the semiconductor industry may be overlooked. Therefore, it is essential for MEXT, as the supervising agency, and the LSTC, which involves Japan's major national universities and research institutions engaged in advanced semiconductor R&D and human resource development, to play an active role in promoting collaboration and the sharing of research, technology, and human resources across regions. Furthermore, when operating hub universities, it is important to actively coordinate educational programs for students with local companies. One of the objectives of the project is to channel trained human resources into the regional semiconductor industry. Thus, for the balanced development of the semiconductor sector, in addition to establishing a hub university system, the simultaneous promotion of nationwide network construction by the government and key institutions, along with collaboration with regional companies, may enable the project to serve as a highly effective measure for human resource development.

[31] Seoul National University, Chonnam National University, Pusan National University, Kyungpook National University, and Chungnam National University.

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