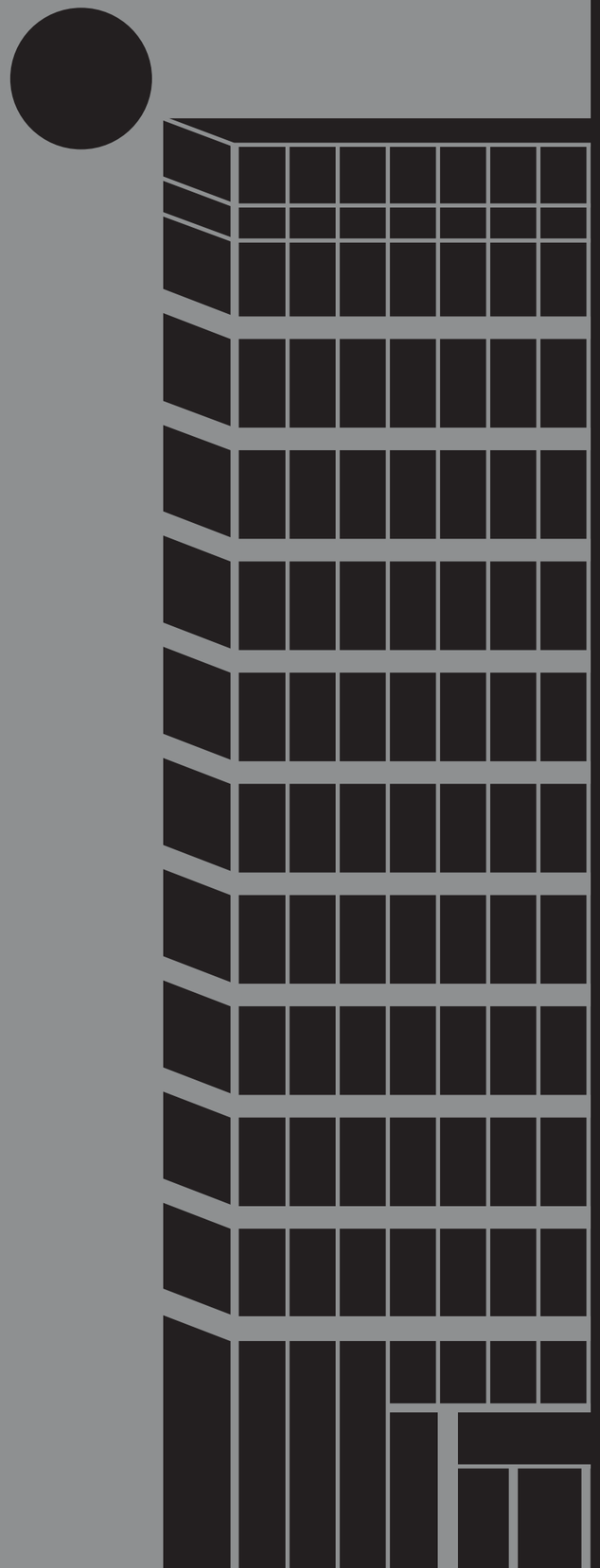


5 Operational Highlights

TSMC manufactured 11,895 different products using 288 distinct technologies for 528 different customers in 2023.

5.1 Business Activities

5.1.1 Business Scope

As the founder and a leader of the dedicated semiconductor foundry segment, TSMC provides a full range of integrated semiconductor foundry services, including leading advanced process and specialty technologies, advanced mask technologies, TSMC 3DFabric® advanced packaging and silicon stacking technologies, excellent manufacturing productivity and quality, as well as comprehensive design ecosystem support, to meet a growing variety of customer needs. The Company strives to provide unparalleled overall value to its customers and views customer success as TSMC's own success. As a result, TSMC has gained customer trust from around the world and has experienced strong growth and success of its own.

TSMC developed or introduced the following technologies in 2023:

Logic Technology

- 2nm (N2) technology development kept on track and made good progress. N2 technology features TSMC's first generation of nanosheet transistor technology with full-node strides in performance and power consumption. Volume production is expected in 2025.
- 3nm fin field-effect transistor (FinFET) (N3) technology entered its second year of volume production in 2023 for customers' smartphone and high performance computing (HPC) products.
- N3 Enhanced (N3E) technology, an enhanced version of N3 technology, will continue to provide industry-leading advantages for both mobile communication and HPC applications. Volume production started in the fourth quarter of 2023.
- N3P technology, an enhanced version of N3E technology, will further provide industry-leading advantages for both mobile communications and HPC applications. Volume production is expected in the second half of 2024.
- N3X technology, a process tailored for HPC applications, was introduced in 2023. Customer product tape-outs are expected to start in 2024.
- 4nm FinFET (N4) technology, an enhanced version of 5nm FinFET (N5) technology, entered its second year volume production in 2023.
- N4P technology with additional performance boost over N4 started volume production in 2023.
- N4X technology, introduced in 2021, is TSMC's first HPC-focused technology, representing the ultimate performance and maximum clock frequencies in TSMC's 5nm family. Customer tape-outs were received in the second half of 2023.
- N5 Plus (N5P) technology, a performance-enhanced version of 5nm technology (N5), entered its third year of volume production in 2023 for customers' smartphones and HPC products.
- 6nm FinFET (N6) technology entered its fourth year of volume production in 2023 and was widely adopted for customers' smartphone, HPC, and digital consumer electronics (DCE) products.
- N6 ultra-low power (ULP) technology – N6e™ development is on track. Its process design kit (PDK) was completed in the fourth quarter of 2023 and the technology is expected to start production in 2024.
- 7nm FinFET (N7) and 7nm FinFET plus (N7+), which have been in volume production for customers' 5G and HPC products for several years, entered their third year of volume production for customers' DCE and automotive products in 2023.
- N12e™ technology, which leverages TSMC's 12nm FinFET compact plus (12FFC+) baseline, started volume production in 2021. Following this, N12e™ technology introduced innovative ultra-low leakage input/output (IO) devices in 2022. This technology started volume production in 2023 to help customers provide more competitive ultra-low power products.
- 22nm ultra-low leakage (22ULL) technology entered its second year of volume production in 2023 and has been widely adopted for Internet of Things (IoT) products.

Specialty Technology

- Based on its N3E technology, TSMC introduced N3 Auto Early (N3AE) program in 2023, providing automotive PDKs to support automotive customers to design in the most advanced 3nm technology for automotive applications.
- N4P radio frequency (N4P RF) technology development was completed, and its V1.0 PDK was available in the fourth quarter of 2023.
- 5nm FinFET Automotive (N5A) technology, an automotive qualified version of 5nm technology (N5) with an automotive design enablement platform, completed technology development and IP AEC-Q100 qualification and certified by ISO26262: Functional Safety – Road Vehicles Standard in 2022. Customer product tape-outs were received in 2023.
- N6 RF technology received multiple customer product tape-outs in 2022. In addition, the second generation N6 radio frequency (N6 RF+) technology is also being developed, and its V0.9 PDK is available in the fourth quarter of 2023.
- 12FFC+ RF technology, developed on the same logic process platform as N12e™ technology, started volume production for customers' 4G cellular RF and IoT wireless connectivity products in 2023.
- 16FFC FinFET compact (16FFC) RF technology received multiple customer tape-outs in 2021. The development of its enhanced version (Enhancement I/II) was completed in 2022 to support applications such as 28/39/47GHz mmWave RF front-end module and 77GHz/79GHz automotive radar. In addition, non-conductive stress (NCS) calculator and aging model were introduced in 2023 to support automotive radar power amplifier designs.
- 16FFC embedded magnetoresistive random access memory (MRAM) technology completed reliability qualification in 2022, with one million cycles endurance and reflow capability. This technology was ready for production and passed AEC-Q100 Grade-1 reliability qualification in 2023.
- 22ULL and 28ULL embedded resistive random access memory (RRAM) technologies, TSMC's second generation of RRAM solutions featuring balanced cost and reliability, entered the second year of volume production in 2023.
- 40nm Silicon on Insulator (N40SOI) technology on 12-inch wafers, which provides industry-leading competitive advantages, entered its second year of volume production in 2023.
- Development of the second generation of 6-inch gallium nitride (GaN) on silicon technology kept on track. This technology will support both DCE and automotive electronics applications and is expected to be ready in 2024. In addition, the 8-inch GaN on Silicon technology development is on track. This technology will support both DCE and automotive electronics applications and is expected to be ready in 2025.
- CMOS image sensor (CIS) technology was enhanced and moved to the next generation to further strengthen the capabilities of advanced automotive CISs. In 2023, TSMC helped customers roll out products with the world's highest dynamic range in performance.
- For silicon photonics technology, TSMC is developing an innovative 3D photonics stack technology – compact universal photonics engine (COUPE), which can integrate silicon photonics chip and electrical control chip into a single-chip photonic engine. This photonics engine can be co-packaged with a HPC chip to provide low power and high speed data transmission. In 2023, the data rate of the test vehicles using TSMC's COUPE technology achieved the expected goal, laying a solid foundation for future volume production.

TSMC 3DFabric® - TSMC Advanced Packaging and 3D Silicon Stacking Technologies

- TSMC-SoIC® Chip-on-Wafer (CoW) technology was qualified for N5-on-N5 stacking and successfully started volume production in 2023.
- TSMC-SoIC® Wafer-on-Wafer (WoW) technology was qualified for stacking 7nm logic wafer on deep trench capacitor (DTC) wafer in 2023 and demonstrated superb system performance enhancement for HPC products.
- Chip on Wafer on Substrate with Silicon Interposer (CoWoS®-S) technology, which integrates multiple system-on-chip (SoC) chips, the third generation high bandwidth memory (HBM3) stacks, and a 3.3-reticle size silicon interposer featuring the second generation of embedded deep trench capacitor (eDTC), was qualified for customer HPC products in 2023.
- Chip on Wafer on Substrate with Redistribution Layer Interposer (CoWoS®-R) technology featuring redistribution layer (RDL) interposer for better signal integrity for HPC applications successfully started volume production in 2023.
- Integrated Fan-Out on Substrate (InFO_oS) technology that extended its capability to integrate multiple homogeneous SoC chips in a 2.5-reticle size fan-out package successfully started volume production in 2023.
- Integrated Fan-Out Multi-chips with Package-on-Package (InFO_M_PoP) technology, which integrates multiple heterogeneous chips with package stacking for wearable products, successfully started volume production in 2023.
- Fine pitch copper (Cu) bump technology for flip chip packaging on 3nm silicon successfully started volume production in 2023.

5.1.2 Customer Applications

TSMC manufactured 11,895 different products for 528 customers in 2023. These chips were used across a broad spectrum of electronic applications, including artificial intelligence (AI) and high-performance computing servers, wired and wireless communication systems, automotive and industrial equipment, personal computers and peripherals and information appliances, as well as consumer electronics such as digital TVs, game consoles, digital cameras, AI-enabled IoT and wearables, and many other devices and applications.

The rapid ongoing evolution of end products prompts customers to pursue product differentiation using TSMC's innovative technologies and services and, at the same time, spurs TSMC's own development of technology. As always, TSMC believes success depends on leading rather than following industry trends.

5.1.3 Consolidated Shipments and Net Revenue in 2023 and 2022

Unit: Shipments (thousand of 12-inch equivalent wafers) / Net Revenue (NT$ thousands)

Shipments		2023		2022	
		Shipments	Net Revenue	Shipments	Net Revenue
Wafer	Domestic (Note 1)	1,551	145,720,682	2,324	202,075,489
	Export	10,451	1,736,797,398	12,929	1,789,780,458
Others (Note 2)	Domestic (Note 1)	N/A	21,637,291	N/A	16,668,631
	Export	N/A	257,580,470	N/A	255,366,714
Total	Domestic (Note 1)	1,551	167,357,973	2,324	218,744,120
	Export	10,451	1,994,377,868	12,929	2,045,147,172

Note 1: Domestic means sales to Taiwan.
Note 2: Others mainly include revenue associated with packaging and testing services, mask making, design services, and royalties.

5.1.4 Production in 2023 and 2022

Unit: Capacity / Output (million 12-inch equivalent wafers) / Amount (NT$ millions)

Wafers			
Year	Capacity	Output	Amount
2023	16-17	11-12	791,773
2022	15-16	15-16	854,900

5.2 Technology Leadership

5.2.1 R&D Organization and Investment

In 2023, TSMC continued to invest in research and development, with total R&D expenditures amounting to 8.5% of revenue, a level that equals or exceeds the R&D investment of many other leading high-tech companies.

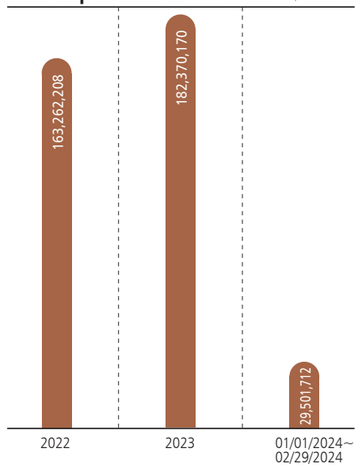
Faced with the continuous challenge of significantly scaling up semiconductor computing power every two years, thereby extending Moore's Law, the Company has focused its R&D efforts on contributing to customers' product success by offering leading-edge technologies and design solutions. In 2023, while the development of 2nm technology continued baseline setup and moved into yield enhancement stage, TSMC started development and made good progress on 14 Angstrom (A14) technology, which aims to further improve speed, power, density and cost. Furthermore, the Company's research efforts continued pushing forward with exploratory studies for nodes beyond 14 Angstrom technology.

In addition to complementary metal oxide semiconductor (CMOS) logic, TSMC conducts R&D on a wide range of other semiconductor technologies that provide the functionality required by customers for mobile system-on-chip (SoC) and other applications. Highlights in 2023 included:

- The Company's integrated interconnect and packaging solution, the 3DFabric® technology service, showed further progress in supporting the newest generation of high bandwidth memory, HBM3E, on both CoWoS®-S and CoWoS®-L. While TSMC continued its industry leadership in high-volume manufacturing of InFO_PoP Gen-8 packaging, InFO_PoP Gen-9 was also fully qualified for mobile applications. In addition, InFO_oS Gen-5 was successfully qualified, offering larger application-specific integrated circuits (ASIC) area, more chip-partition integration, larger package size and higher bandwidth.
- In specialty technologies, examples of progress included: 0.13μm and 90nm BCD (Bipolar-CMOS-DMOS) technologies were expanded to meet the demand of the automotive market; TSMC's industry leading GaN (Gallium Nitride) power device technology, the second generation of 650V and 100V E-HEMT, entered the reliability verification stage with production expected in 2024; the worldwide first CMOS image sensor technology with 3D-MiM embedded LOFIC (lateral overflow integration capacitor) pixel with a high dynamic range (DR>100dB) for high-end smart phone or advanced driver-assistance systems (ADAS) automotive imaging applications entered risk production; and the world's first mass-production of 22nm consumer-grade magnetoresistive random access memory (MRAM) was achieved.

In 2023, TSMC maintained strong partnerships with many world-class research institutions, including SRC in the U.S. and IMEC in Belgium. The Company also continued to expand research collaboration with leading universities throughout the world for two major purposes: the advancement of semiconductor technologies and the nurturing of human talent for the future.

R&D Expenditures Amount: NT$ thousands



5.2.2 R&D Accomplishments in 2023

Highlights

- 2nm Technology

In 2023, TSMC's 2nm technological development focused on baseline setup, yield enhancement, transistor and interconnect R/C performance improvement, and reliability evaluation. During the year, major customers completed IP design and started silicon validation. The Company also developed low resistance RDL (redistribution layer), super high performance metal-insulator-metal (MiM) capacitors and backside power delivery network to further boost performance.

- A14 Technology

Development of the 14 Angstrom (A14) platform technology, targeting both SoC and HPC applications, made good progress in 2023. 14 Angstrom platform technology is expected to offer excellent improvement in speed, power, density and cost over 2nm technology.

- Lithography Technology

In 2023, TSMC R&D demonstrated high performance and expected wafer yield for the development of 2nm technology.

The Company's R&D efforts in lithography have been focused on improving patterning and material quality, controlling variations, reducing defects, and lowering costs to support 2nm technology. Looking ahead to A14 and beyond, TSMC R&D will continue to explore next-generation EUV (extreme ultraviolet) lithography scanners, conduct research on mask pellicles and blanks to support leading-edge technology and extend Moore's Law. Furthermore, TSMC R&D will continuously evaluate new process technologies and materials to enhance lithography capabilities in the future.

- Mask Technology

In 2023, to achieve the wafer yield and productivity for lithography requirements at 2nm node, the R&D team improved the critical dimension, pattern fidelity, overlay stability, exposure durability and defect mitigation of curvilinear patterns by EUV photoresist and blank material modification, multi-beam writer resolution enhancement, mask process recipe optimization, and advanced deep learning inspection. Future improvements will focus on developing new blank materials and new mask process technology at the A14 node and beyond.

Integrated Interconnect and Packaging

TSMC's existing fine pitch, chip-to-chip connection leveraging wafer processes is called 3DFabric® and consists of both wafer-level frontend and backend technologies. The Company's frontend technologies, or TSMC-SoIC®, enables leading-edge silicon for 3D silicon stacking. TSMC's advanced backend technologies includes CoWoS® with chips placed onto pre-made RDLs and InFO with chips embedded before interconnection. The Company's 3DFabric® technology service offers the ultimate flexibility in product design with integrated frontend and backend technologies to meet future computing systems integration scaling needs.

- 3DIC and TSMC-SoIC®

TSMC-SoIC® wafer product is an innovative wafer-level frontend 3DIC chip stacking platform with outstanding bonding density, interconnect bandwidth, power efficiency, and thin profile. It extends Moore's Law through system-level scaling with sustainable performance gains and corresponding cost benefits. SoIC integrated chips can be subsequently assembled by using conventional packages or TSMC's new 3DFabric® technology service, such as CoWoS® or InFO, for next generation HPC, AI and mobile applications. The SoIC CoW Face-to-Back Gen-1 process is in production and the SoIC CoW Face-to-Back Gen-2 process, with significant thermal performance improvement, is under product qualification and will enter production phase in 2024. The SoIC CoW

Face-to-Face Gen-1 process is under development and will provide an ultrahigh density connection solution in 2025. TSMC will continue to pursue SoIC technological improvements and co-optimize with the Company's advanced silicon technologies for further gains in transistor density, system power/performance/area and cost.

• CoWoS®

CoWoS® advanced packaging service is the leading 2.5D technology to make ultra-high-performance AI and HPC packages by integrating most advanced logic and memory dies on an interposer. Market demands became even greater with the advent of generative AI in late 2022. TSMC qualified the CoWoS®-S Si interposer up to 3.3-reticle size (1 reticle size ~830mm^2), with volume production launched in 2023. Beyond 3.3-reticle size, CoWoS®-L with reconstituted interposer of multiple LSIs (local silicon interconnects) increases the momentum for continuous interposer scaling. After its successful development in 2023, the first generation CoWoS®-L technology will enter volume production in 2024. HBM3E, the newest generation of high bandwidth memory, is ready now for production on both CoWoS®-S and CoWoS®-L, while the next generation of stacked memory of HBM4 and process upgrades in CoWoS® advanced packaging service are being planned to meet new performance requirements.

• InFO

In 2023, TSMC continued its industry leadership in high-volume manufacturing of InFO_PoP Gen-8 packaging for mobile applications. InFO_PoP Gen-9 was also successfully qualified for mobile applications, as was InFO_oS Gen-5, offering larger application-specific integrated circuits (ASIC) area, larger package size and higher bandwidth. InFO_M_PoP Gen-1, which integrates different functional chips suitable for wearable applications, started volume production in 2023, while the next-generation InFO_PoP with backside RDL for integrated low power DDR DRAM technology (LPDDR) was qualified in 2023 and is ready for volume production in 2024.

• Advanced Interconnect

TSMC's continuous striving for excellence and focus on innovative interconnect technologies empower its customers to design and manufacture highly competitive products. In 2023, the Company developed a unique backend-of-line process that reduces via resistance. In addition, TSMC research on new materials for future interconnect applications demonstrated significant line resistance reduction. These state-of-the-art technologies will reinforce TSMC's technology leadership in semiconductor field.

Corporate Research

TSMC remains at the forefront of 2D transistor research with innovation in devices and materials to enable extremely scaled logic transistors. At the 2023 Symposia on VLSI Technology and Circuits, the Company demonstrated contact length scaling with record low contact resistance. Monolayer-MoS_2 channel transistors have the same driving current at contact length down to 30nm. At the 2023 International Electron Device Meeting (IEDM), TSMC successfully demonstrated the first stacked nanosheet devices with two 2D monolayer MoS_2 channels. With gate dielectric optimization, the Company also showed high performance 40nm gate length 1L-MoS_2 single nanosheet n-FET with a high on-state current. Also at the 2023 IEDM, TSMC demonstrated, for the first time, n-type MoS_2 and p-type WSe_2 2D FET with comparable high on-state current. This on-state current for 2D p-FET also set a record for high performance. CMOS demonstration with co-integration of MoS_2 n-FET and WSe_2 p-FET on the same chip resulted in nearly unaltered performance.

The Company continues to research emerging high-density, non-volatile memory devices and hardware accelerators for AI and HPC applications. At the 2023 IEDM, TSMC presented a new 1S1R device based on the arsenic-free SNGCT chalcogenide selector and on the STT-MRAM memory element. This 1S1R device demonstrated excellent write and read performance, including low write voltage, high speed, low write error rate, high write endurance, and excellent immunity to read disturb. At the 2023 International Solid-State Circuits Conference (ISSCC), TSMC demonstrated a nonvolatile AI-Edge processor with 4MB hybrid-mode ReRAM compute-in-memory (CIM) macro. This CIM macro includes configurable circuits supporting both near-memory computing (NMC) and in-memory computing (IMC) modes within a macro. Among reported nonvolatile AI-edge processors, the proposed 22nm AI-edge processor achieved the highest energy efficiency.

Specialty Technologies

TSMC offers a broad array of technologies to address a wide range of applications:

• Mixed Signal/Radio Frequency (MS/RF)

While global consumer electronics were impacted by the aftermath of economic uncertainty triggered by COVID-19, in 2023 TSMC introduced N6RF+ technology to provide an alternative, cost-effective option to solve the excess inventory in smartphone markets and also provided N4RF for more high-end RF applications. To address the market in mmWave and RF frontend modules, the Company made continuous enhancements in N28HPC+ and N40SOI RF technologies by value-added design technology co-optimization (DTCO) as verified by many win-win solutions with customers. TSMC provided services for other RF technologies aimed at new emerging markets, such as low earth orbit (LEO) satellites and autonomous vehicles, in the form of RF process design kits (PDKs) with the most powerful ecosystem and time-to-market advantages from circuit design to product verification.

• Power IC/Bipolar-CMOS-DMOS (BCD)

In 2023, TSMC continued to improve its competitiveness in the 12-inch BCD technology process by expanding its 0.13μm and 90nm BCD technology to meet the demand of the automotive market, where the 0.13μm to support 45V operation is currently undergoing reliability verification and is expected to be launched in 2024. The 55nm BCD has been successfully put into mass production and offers multiple 5V solutions for high-performance and low-power mobile applications. The second-generation of 40nm BCD and ultra-low power (ULP) process are fully compatible with 5-28V high-voltage components, thereby enabling more power management chip applications. The Company also successfully developed a 5V operated 6nm FinFET device for RF power amplifiers in high-end SoC.

• Micro-Electromechanical Systems (MEMS)

In 2023, TSMC implemented qualified piezoelectric micro electromechanical systems (MEMS) technology for the sampling of in-ear dynamic vent application, which could optimize user experience for wireless earphones and strengthen customers' competitiveness. In parallel, TSMC's next generation monolithic CMOS-MEMS technology was qualified to produce 6-axis inertial measurement unit (IMU) for automotive with high frequency vibration rejection capability to enable reliable and accurate responses regardless of different vehicle designs and road conditions. Future plans include the development of next-generation environmentally friendly piezoelectric technology, and ultrasound transducer applications.

• Gallium Nitride (GaN)

TSMC's second generation of 650V and 100V E-HEMT entered the reliability verification stage in 2023, maintaining the Company's leading position in the field of GaN power devices. The reliability test is expected to be completed in 2024 and then put into production. Meanwhile, to enhance customer product competitiveness, TSMC is also developing 8-inch 650V HEMTs for power devices in automotive electronics, expected to be launched in 2025.

• Display Drivers

TSMC completed 28nm HV product IC yield and reliability verification in 2023 and will start production in 2024. To bolster the Company's leading position in the field of high voltage display driver technologies, TSMC is developing 16nm high voltage FinFET with better performance and lower power usage for customers to design more competitive OLED display driver ICs.

• Complementary Metal-Oxide-Semiconductor (CMOS) Image Sensors

TSMC achieved several accomplishments in CMOS Image Sensor technology in 2023, including (1) risk production of the worldwide first 3D-MiM embedded LOFIC pixel with a high dynamic range (DR>100dB) for high-end smartphones or ADAS automotive imaging applications; (2) technology transfer of an enhanced 3D-MiM (2.5X capacitance boost) embedded voltage domain global shutter (VDGS) CMOS image sensor to a manufacturing fab; (3) demonstration of TSMC's next generation Si SPAD (single photon avalanche diode) technology with 55% pixel area shrinkage and 2X PDE improvement for more advanced and powerful 3D depth sensing applications; and (4) demonstration of new generation Ge/Si heterogeneous photodetector with 90% dark current reduction for SWIR (short-wave infrared radiation) 3D depth and bio signal sensing applications.

• Emerging Memory/Memory WoW Stacking Technology

The Company reached several major milestones in emerging memory technologies in 2023. TSMC offered RRAM as a low-cost embedded NVM (Non-Volatile Memory) solution for the price sensitive IoT market. The Company's 40nm, 28nm and 22nm nodes entered volume production, while 12nm and the next generation also entered development stage.

TSMC has achieved the world's first mass-production of 22nm consumer-grade MRAM. Moreover, the Company has taken steps to enhance its properties to meet automotive grade applications on the 22nm node. In 2023, TSMC successfully completed the technical qualification of the 16nm consumer-grade MRAM. Going forward, TSMC will collaborate closely with customers to develop an automotive grade 16nm

MRAM, as well as explore the next generation of 16nm embedded MRAM technology and focus on reducing the bit cell size for cost efficiency to accelerate the deployment of future technologies for software-defined vehicles (SDVs), smart sensor and edge-AI applications.

TSMC developed 55nm node logic wafer and dynamic RAM heterogeneous wafer stacking processes, not only increasing data transfer bandwidth but also significantly reducing power consumption, with mass production already underway in 2023. TSMC also verified the wafer stacking technology of 28nm node RRAM. The electrical performance and reliability passed the test, providing a solution for high performance computing. In addition, TSMC demonstrated the wafer stacking technology of 22nm node MRAM, which is expected to meet the high speed and low power requirements of AI computing.

5.2.3 Technology Platform

TSMC provides customers with advanced technology platforms that include the comprehensive infrastructure needed to optimize design performance, power, area (PPA) and cycle times. These include electronic design automation (EDA) design flows; silicon-proven libraries and IPs; and simulation and verification design kits, also known as PDKs, and technology files.

For the latest advanced technologies such as 2nm, 3nm, 4nm and 3DFabric®, the Company provides certified EDA tools, features and IP solutions for customer adoption at various design stages to meet their product requirements. To help customers plan new product tape-outs incorporating library/IP from the Company's Open Innovation Platform® (OIP) ecosystem, the OIP ecosystem features a portal to connect customers to solution providers from 14 EDA partners, seven Cloud partners, 39 IP partners, 26 design center alliance (DCA) and nine value chain aggregator (VCA) partners, as well as 22 partners with 3DIC expertise in the new 3DFabric® Alliance.

5.2.4 Design Enablement

TSMC's technology platforms provide a solid foundation to facilitate the design process. Customers can design using the Company's internally developed IPs or use IPs and EDA tools available from TSMC's OIP partners.

Tech Files and PDKs
EDA tool certification, an essential element for IP and customer designs to ensure that features meet TSMC process technology requirements, can be found on TSMC-Online. Corresponding technology files and PDKs are available for customers to download and use with certified EDA tools. TSMC provides a broad range of PDKs for digital logic, mixed-signal, radio frequency (RF), high-voltage driver, CMOS image sensor (CIS) and embedded flash technologies from 0.5μm to 2nm. In addition, the Company provides technology files for design rule checking (DRC), layout versus schematic (LVS), resistance-capacitance (RC) extraction, automatic place and route, and a layout editor to ensure that process technology information is accurately represented in EDA tools. By 2023, TSMC had provided customers more than 48,000 technology files and 3,400 PDKs.

Library and IP
Silicon intellectual property (IP) is the basic building block of IC designs. Various IP types are available to support different customer design applications including: foundation, analog/mixed-signal, embedded memory, interface and soft IP. TSMC and its alliance partners offer customers a rich portfolio of reusable IPs, which are building blocks for many circuit designs. To support 3DIC customer needs, TSMC introduced 3DIC IP in 2019. By 2023, the Company had expanded its library and silicon IP portfolio to contain more than 73,000 items, a 33% increase over 2022.

Design Methodology and Flow
Design reference flows are developed based on certified EDA tools to provide robust and comprehensive design methodology innovations that can help boost productivity. In 2023, TSMC released N2 HPC, mobile and custom design reference flows through OIP collaboration and announced their availability for customer adoption. In addition to process technology advancements, the Company released the design reference flows for analog design migration 2.0, N16 79GHz mmWave and N4P RF sub-10GHz technologies, and continued to develop and offer 3DFabric® design solutions for both 3D chip stacking and 2.5D advanced packaging technologies, including solutions supporting the 3Dblox standard, to reduce 3DIC design barriers, thus helping customers to improve productivity in their system-level designs. These design reference flows feature FinFET-specific and 3DFabric® design solutions to optimize PPA.

5.2.5 Intellectual Property

For a long time, TSMC has been protecting R&D innovation and operation development by way of utilizing patents and trade secrets as dual tracks under the established comprehensive IP management system, encouraging Company's innovation culture, and strengthening Company's competitive strengths so as to fulfill the Company's ESG vision. TSMC's General Counsel updates the Board of Directors on the status of the intellectual property management scheme.

TSMC's comprehensive patent management system includes: Patent management strategies, such as Global patent deployment, Exploratory invention mining, Patent portfolio expansion, and Patent exploitation and exercise; and Patent management rules, such as Tier-based IP evaluation, Patent competition rewards, Educational patent promotion, and Patent professional training. TSMC has established technological patent road maps by way of innovative patent strategy, strict management and risk-control measures; analyzed and monitored competitors by using intelligent patent maps; conducted core technology mining through invention workshops; expanded patent families on key technologies; filed and maintained patents by tier-based management, further enhanced patent protection through quality control on patent applications and continued to construct massive global patent portfolio with high quality; and, diversified exploitation of patent assets. In terms of patent filings, TSMC has accumulated more than 94,000 patent applications worldwide as of end of 2023, including 8,700+ applications filed in 2023. TSMC ranked No. 2 among global U.S. patent applicants, and No. 1 among patent applicants in Taiwan. In terms of patent grants, TSMC has accumulated 62,000+ patents worldwide as of end of 2023, including more than 6,000 global patents received. TSMC ranked No. 3 among U.S. Patentees, and No. 1 among patent patentees in Taiwan. In terms of patent quality, the allowance rate of TSMC's U.S. applications approached 100%.

Turning to trade secret management and strategy, 10 years after TSMC pioneered the "Trade Secret Registration System" in 2013, followed by the adoption of numerous intelligent management programmes, TSMC successfully launched the "Trade Secret Intelligent Management Version 2.0" and piloted the "Trade Secret Innovation Talent Scouting Online Merge Offline Service" in specific departments selected by a customized artificial intelligence (AI) system at Fab 12B, Fab 15A, and Fab 15B in 2023. By leveraging AI, static data from registered trade secrets were intelligently utilized to select colleagues with innovative potential by analyzing innovation indicators of their registered trade secrets. One-on-one, tailored guidance were provided to these colleagues by enthusiastic senior managers who have won several Golden Trade Secret Awards in the past to elevate their innovation's quality and generate more exceptional trade secrets. Through the transformational synergistic effects of quality and quantity, a continuous upward spiral of innovation is generated, strengthening the company's sustainable innovative culture and competitive advantage. The pilot run demonstrated that not only 18 inventors with innovation potential were successfully mentored by 6 Golden Coaches, but it also verified the feasibility of this novel initiative. This laid the foundation for future expansion and implementation in other fabs and divisions.

TSMC identifies and rewards impactful and high-quality innovations through the annual Golden Trade Secret Award ceremony, presenting 2,738 trade secrets with the Golden Trade Secret Award between 2013 and 2023. In addition, immense innovative drive and potential are illustrated through the 348,503 trade secrets registered thus far and with annual registrations exceeding 100,000 cases for the first time in 2023.

TSMC established the "Green Trade Secret Registration" column in 2021, and in 2023 alone recorded 633 registrations, a 500% increase from 2021's registration numbers, demonstrating how much TSMC's colleagues value Green Trade Secrets. Participating employees who registered for Green Trade Secrets span across multiple departments. On top of the Facility department, departments such as R&D and Manufacturing also participated enthusiastically in recording innovations contributing to sustainability, energy conservation, and carbon emission reduction, enriching the innovation diversity of Green Trade Secrets.

TSMC received a AAA (the highest tier) certificate by Taiwan Intellectual Property Management System (TIPS) in December 2021, and the valid period will expire after December 31, 2024.

TSMC's IP team works closely with technical teams from R&D in early stage to mass production, and actively constructs IP portfolio for each key innovative technology, including the latest technology nodes, so as to ensure Company's technology leadership in semiconductor field; TSMC utilize patents and trade secrets as dual tracks to successfully protect Company's

main business including process technologies, designs, manufacturing and sales, and have been strategically utilized for defense and cross-license negotiation, so as to secure freedom of business operation worldwide.

5.2.6 TSMC University Collaboration Programs

In recent years TSMC has collaborated closely with several prestigious universities in Taiwan to carry out a variety of joint research projects. These collaborations encourage more university professors to conduct leading-edge semiconductor research in areas such as novel devices, process, materials manufacturing technologies, specialty technologies for electronic applications, and green manufacturing. At the same time, these projects provide hands-on training opportunities for students interested in these fields to prepare them for joining the semiconductor industry after graduation. Starting in 2013, TSMC established research centers at four top universities in Taiwan: National Yang Ming Chiao Tung University, National Taiwan University, National Cheng Kung University and National Tsing Hua University. In the past ten years, a total of 295 professors and more than 3,800 students with backgrounds in the disciplines of electronics, electrical engineering, physics, materials, chemistry, chemical engineering, and mechanical engineering have joined the research centers. In 2022, TSMC also actively supported the establishment of semiconductor or key technology research academies at National Taiwan University, National Cheng Kung University, National Tsing Hua University, National Yang Ming Chiao Tung University, National Sun Yet San University, and National Chung Hsing University, providing continuous funding for forward-looking research in Taiwan's semiconductor field and planning scholarship programs to encourage students who are interested in the field. In 2019, the Company jointly launched the TSMC-NTHU Semiconductor Program to enhance the quality and number of domestic semiconductor students and attract more outstanding students to a career in the semiconductor industry. By 2023, the list of school partners had grown to thirteen universities, including National Taiwan University, National Cheng Kung University, National Yang Ming Chiao Tung University, National Taipei University of Technology, National Taiwan University of Science and Technology, National Central University, National Sun Yet San University, National Chung Hsing University, National Chung Cheng University, Feng Chia University, Yuan Ze University, and Chung Yuan Christian University, with over 7,600 students enrolled to date. In addition, TSMC has long conducted strategic research projects at top overseas universities such as Stanford University, Massachusetts Institute of Technology, Princeton University, University of California, San Diego, University of Texas at Austin, University of Toronto, and the University of Tokyo and so on, focusing on innovative capabilities in transistors, interconnect, materials, device simulation and circuit design.

TSMC University Shuttle Program

The TSMC University Shuttle Program was established to provide professors at outstanding research universities worldwide with access to the leading silicon process technologies needed to develop innovative circuit design concepts. In 2023, TSMC teamed up with the Taiwan Semiconductor Research Institute (TSRI) to apply the successful customer experience to the University Shuttle Program. 16 nm technology is available at TSRI for advanced students to design, enabling their creativity to be transformed into physical chips. The University Shuttle Program provides access to TSMC silicon process technologies for digital and analog/mixed-signal circuits, RF designs, non-volatile memory design and ultra-low power designs. TSMC and the University Shuttle Program participants enjoy win-win collaboration through the program, which allows graduate students to implement exciting designs and achieve silicon proof points for innovation in various end-applications.

5.2.7 Future R&D Plans

To maintain its technology leadership, TSMC plans to continue investing heavily in R&D. While TSMC's 2nm and 14 Angstrom advanced CMOS logic nodes are progressing through the development pipeline, the Company's exploratory R&D work is focused on nodes beyond 14 Angstrom, and on areas such as 3D transistors, new memories and low-R interconnect, to lay a strong foundation to foster the development of innovative technology platforms in the future. TSMC's 3DFabric® advanced packaging R&D is developing innovations in subsystem integration to further augment advanced CMOS logic applications. The Company maintains its intensified focus on new specialty technologies such as RF and 3D intelligent sensors for 5G and smart IoT applications. TSMC research continues to develop novel materials, processes, devices and memories that may be adopted in the distant future, ten years and beyond. The Company also continues to collaborate with external research bodies from academia and industry consortia alike with the goal of gaining early awareness and adoption of future cost-effective technologies and manufacturing solutions for its customers. With a highly competent and dedicated R&D team and unwavering commitment to innovation, TSMC is confident in its ability to drive future business growth and profitability for years to come, by delivering advanced competitive semiconductor technologies to its customers.

Summary of TSMC's Major Future R&D Projects

Project Name	Description
2nm logic technology platform and applications	3D CMOS technology platform for SoC
A14 and beyond logic technology platform and applications	3D CMOS technology platform for SoC
3DIC	Cost-effective solutions with better form factor and performance for 3DIC integration
Next-generation lithography	Next-generation EUV lithography and related patterning technology to extend Moore's Law
Long-term research	Specialty SoC technology (including new NVM, MEMS, RF, analog) and transistors with 8 to 10 years horizon

The projects above account for roughly 73% of the total R&D budget for 2024. Total R&D budget is estimated to be around 8% of 2024 revenue.

5.3 Manufacturing Excellence

5.3.1 GIGAFAB® Facilities

Maintaining reliable production capacity is a key manufacturing strategy at TSMC. The Company currently operates four 12-inch GIGAFAB® facilities – Fab 12, 14, 15 and 18. The combined capacity of the four facilities exceeded 12 million 12-inch wafers in 2023. Production within these facilities support 0.13μm, 90nm, 65nm, 40nm, 28nm, 16nm, 7nm, 5nm and 3nm process technologies and their sub-nodes.

The GIGAFAB® facilities are coordinated by a centralized management system known as super manufacturing platform (SMP) to provide customers with consistent quality and reliability, greater flexibility to cope with demand fluctuations, and faster yield learning and time-to-volume production, as well as lower-cost product requalification. In July 2023, TSMC inaugurated its global R&D center specializing in the technology development of 2nm nodes and beyond and to support the exploration of new materials and research on transistors structures. In addition, in response to strong market demand for 3DIC, TSMC opened and started operating its Advanced Packaging Fab 6 also in June 2023 as to provide comprehensive semiconductor manufacturing services from frontend to backend and testing.

5.3.2 Engineering Performance Optimization

As advanced technology continues to evolve and IC geometry keeps shrinking, the need for tighter manufacturing process and quality control becomes extremely challenging. TSMC has tailored its manufacturing infrastructure to handle a diversified product portfolio that uses strict process control to meet tightened specs and higher product quality, performance and reliability requirements from customers. TSMC's process control systems are integrated with numerous intelligent functions to achieve excellence in both quality and manufacturing. Through intelligent detection, smart diagnosis, and cognitive action, the Company produces remarkable yield enhancement, quality assurance, workflow improvement, fault detection, and cost reductions, while shortening its R&D cycle.

To meet 5G's stricter quality requirements for mobile, high performance computing (HPC), automotive and the Internet of Things (IoT), TSMC is implementing artificial intelligence (AI) and machine learning technologies, and has developed systems for precise fault detection and classification, intelligent advanced equipment control and intelligent advanced process control to ensure the consistency of tool matching and process stability. Combining intelligent process variation detection with foundry know-how to identify potential defects and minimize the convergence of process variation through self-diagnosis and cognitive action. As the result, each chip can be precisely controlled at the nanometer level to produce the highest quality wafers for customers.

5.3.3 Agile and Intelligent Operations

The Company's sophisticated, agile and intelligent operating system drives manufacturing excellence. TSMC has integrated process experience, machine tuning, manufacturing know-how, and AI technologies to create an intelligent manufacturing environment. Intelligent manufacturing technologies are widely applied to lean manufacturing, employee productivity, equipment productivity, process and equipment control, quality defense, and robotic control to optimize quality, productivity, efficiency, and flexibility. The end result is real-time information analysis, improved forecast capability, maximum cost effectiveness, and accelerated innovation. TSMC has also integrated new applications such as intelligent mobile devices, IoT, edge computing, and mobile robot, with intelligent automated material handling systems (AMHS) to consolidate wafer manufacturing data collection and analysis, utilize manufacturing resources efficiently,

and maximize manufacturing effectiveness. TSMC continues to improve semiconductor production through AI that uses massive amounts of production data to achieve agile and intelligent operations.

5.3.4 Digital Transformation

To meet strong pent-up demand from customers, TSMC continues to implement technology to transform the "automated fab" into the "intelligent fab," with the simultaneous improvement of product quality, equipment capacity, and personnel effectiveness. Intelligent fab has integrated the domain knowledge of semiconductor manufacturing, enabled system self-learning, and expanded the application of AI and machine learning, which includes dispatching, equipment tuning, process control, equipment diagnosis and maintenance, and quality inspection. This frees today's engineers to focus on problem solving. Looking ahead to the future, all manufacturing improvement plans and productivity enhancements within the factory can be synchronized across global factories through the Global Manufacturing and Management Platform. Furthermore, the implementation of augmented reality (AR) and remote operation platforms will provide greater flexibility and efficiency in cross-factory machine maintenance and operations, thereby enabling a collaborative model to achieve operational efficiency and manufacturing quality consistency across all factories.

5.3.5 Raw Materials and Supply Chain Management

In 2023, TSMC, together with suppliers, continued to review and resolve supply and quality issues as well as potential supply chain risks through the collaboration of teams formed by fab operations, quality control and business organizations. TSMC also worked with suppliers to drive research and process innovation for advanced materials, strengthen quality, and save energy and reduce carbon emission in the supply chain to achieve a sustainable supply chain and create benefits from win-win solutions.

Raw Materials Supply

Major Materials	Major Suppliers	Market Status	Procurement Strategy
Raw Wafers	FST GlobalWafers SEH Siltronic SK siltron SUMCO	These 6 suppliers together provide over 90% of the world's raw wafer supply.	•TSMC's suppliers of silicon wafers are required to pass stringent quality certification procedures. •TSMC procures wafers from multiple sources to ensure adequate supplies for volume manufacturing and to appropriately manage supply risk. •Raw wafer quality enhancement programs are in place to support TSMC's technology advancement. •TSMC regularly reviews the quality, delivery, cost, sustainability and service performance of its wafer suppliers. The results of these reviews are incorporated into subsequent purchasing decisions. •A periodic audit of each wafer supplier's quality assurance system ensures that TSMC can maintain the highest quality in its own products. •TSMC takes various approaches with suppliers to optimize cost and supply.
Chemicals	Air Liquide BASF DuPont Entegris Fujifilm Electronic Materials Kanto PPC Kuang Ming Merck RASA Shiny Tokuyama Wah Lee	These 12 companies are the major worldwide suppliers of chemicals.	•Most suppliers have located their new operations closer to TSMC's major manufacturing facilities, thereby significantly improving procurement logistics and reducing supply risk. •All supplied products are regularly reviewed to ensure that TSMC's specifications are met and product quality is satisfactory. •In order to effectively manage costs and supply chain, TSMC has collaborated with suppliers and adopted various strategies. •TSMC encourages and collaborates with chemical suppliers to implement innovative green manufacturing improvement programs.
Lithographic Materials	DuPont Fujifilm Electronic Materials JSR Nissan Shin-Etsu Chemical Sumitomo Chemical T.O.K.	These 7 companies are the major worldwide suppliers of lithographic materials.	•TSMC works closely with suppliers to develop materials that meet all application and cost requirements. •TSMC and suppliers periodically conduct programs to improve their quality, delivery, sustainability and green policies, and jointly set improvement programs and monitor progress to ensure continuous improvement in TSMC's supply chain.
Gases	Air Liquide Air Products Central Glass Entegris Linde LienHwa Merck SK specialty Co., Ltd. Taiwan Material Technology Nippon Sanso Taiwan	These 9 companies are the major worldwide suppliers of specialty gases.	•The majority of these suppliers have facilities in multiple geographic locations, which minimizes supply risk for TSMC. •TSMC conducts periodic audits to ensure that these suppliers meet TSMC's standards.
Slurry, Pad, Disk	3M AGC Entegris DuPont Fujibo Fujifilm Electronic Materials Fujimi	These 7 companies are the major worldwide suppliers of CMP (Chemical Mechanical Polishing) materials.	•TSMC works closely with suppliers to develop materials that meet all application and cost requirements. •TSMC and suppliers periodically conduct programs to improve their quality, delivery, sustainability and green policy, and jointly set improvement programs and monitor progress to ensure continuous improvement in TSMC's supply chain. •Most suppliers have relocated or plan to establish new manufacturing sites closer to TSMC's major manufacturing facilities, thereby significantly improving procurement logistics and reducing supply risks.

Suppliers Accounting for at Least 10% of Annual Consolidated Net Procurement in 2023 and 2022

Unit: NT$ thousands

Supplier	2023			2022		
	Procurement Amount	As % of 2023 Total Net Procurement	Relation to TSMC	Procurement Amount	As % of 2022 Total Net Procurement	Relation to TSMC
Company A	17,862,380	20%	None	18,259,301	20%	None
Company B	17,763,637	20%	None	16,120,039	18%	None
Others	53,109,061	60%	-	56,546,611	62%	-
Total Net Procurement	88,735,078	100%	-	90,925,951	100%	-

- **Reason for Increase or Decrease:** The changes of procurement amount and percentage were mainly due to customer product demand change.

5.3.6 Quality and Reliability (Q&R)

TSMC strives to offer excellence in semiconductor manufacturing services to all its customers worldwide. The Company is dedicated to providing outstanding quality in every facet of its business and maintains a culture of continuous improvement to assure customer satisfaction. TSMC implements containment and preventive measures to protect customers from potential product defects.

In the technology development stage, the Q&R organization helps customers design in superior product reliability. In 2023, Q&R worked continuously with R&D in advanced logic, specialty and advanced packaging technologies throughout development and qualification stages to ensure meeting commitments to customers with respect to device characteristics, process yield and product reliability.

For advanced logic technology, following 3nm FinFET, Q&R successfully certified N3E, which is an enhanced version of 3nm processes for better power, performance and density. For specialty technologies, Q&R successfully qualified consumer-grade 22nm embedded MRAM process enhancement IP and completed reliability certification for 28nm HV (high voltage) technology. In addition, TSMC's advanced packaging solutions enabled system improvement of the wafer level process by integrating the frontend wafer process and backend chip packaging. In 2023, Q&R completed the qualification and entered volume production

of TSMC-SoIC® stacking technology, which stacks chips on wafers (CoW). TSMC also successfully certified the CoWoS® advanced packaging technology on larger substrates, enabling the 3DFabric® technology platform to be applied to artificial intelligence and high-speed computing. In terms of advanced packaging technology, TSMC has successfully certified the InFO_PoP technology for advanced N3 chips and power management ICs (PMICs), achieving higher efficiency and lower power consumption in mobile devices.

To continuously reduce product defects, enhance process controls, facilitate early detection of abnormalities and prevent quality problems in general, Q&R collaborates with other operational entities to establish and continuously improve real-time defense systems using advanced statistical methods and quality tools. Q&R and the Company's fabs have also worked together on enhancements for automotive product quality improvement, including design rule implementation and migration to Automotive Quality System 2.0. This covers process capability requirements to tighten in-line and wafer acceptance testing in fabs and the handling of maverick wafers and lots. Q&R also provides dedicated resources for field/line return analysis and timely physical failure analysis (PFA) for process improvement to meet automotive customers' stringent defective parts per million (DPPM) requirements.

To stimulate employee problem-solving and develop related quality systems and methodologies, Q&R held several company-wide symposia and training programs on total quality excellence (TQE) in 2023. Q&R has successfully completed a series of digital transformation development tasks, applied in areas such as raw material management, statistical process control (SPC), metrology, and laboratory analysis. By leveraging advanced digital technologies and platforms, TSMC achieved its digital transformation goals. Moreover, during the initial phase of overseas expansion, Q&R addressed the challenges of personnel training, remote management, and support through digital transformation. This has made the successful practice of globalized management possible, achieving zero distance and zero time difference in quality management across global fabs. In 2024, Q&R will continue to promote the development of quality management methods and professional training and apply artificial intelligence technologies to consolidate TSMC comprehensive competitive advantages in this industry.

Q&R is committed to quality excellence, responsible supply chain, green manufacturing, and sustainable management practices. Q&R has established a state-of-the-art chemical lab responsible for monitoring raw material quality, assisting R&D organizations in the breakthrough of cutting-edge materials, and improving the yield of products and processes. In addition, Q&R and its chemical lab also assist the supply chain in material innovation, guiding suppliers to ensure compliance with international regulation for carcinogenic, mutagenic and reprotoxic (CMR) substances and to classify risky materials and carry out test sampling. In addition, Q&R applies best known methods based on professional expertise and collaborates with the materials supply chain management division to build a resilient raw material supply chain. Even in the face of pandemic restrictions, geopolitical tensions and material shortages, TSMC successfully expanded existing material production capacity with suppliers, established new production lines of verified quality at overseas bases, and developed sufficient qualified second sources. All the efforts above have supported TSMC in navigating through geo-political turmoil to achieve continuous growth and optimize the balance between quality and capacity.

Furthermore, Q&R assisted suppliers in developing recycling projects, enabling several recycled chemicals to achieve an electronic grade quality level. Q&R also collaborated with operations to conduct engineering verification for recycled chemicals, meeting TSMC's quality requirements and environmentally friendly sustainability goals. Q&R is also committed to the continual improvement of local supply chains and developing local talent. In 2023, TSMC again collaborated with the Semiconductor Equipment and Materials International (SEMI) to hold the fifth Strategic Materials Conference (SMC) in Taiwan and invited domestic and overbroad members to share the most advanced material technology, to motivate talented personnel and elevate the international competitiveness of the local supply chain. In addition, in 2023 Q&R collaborated with a professional consulting firm to participate in the Electronic Specialty Gases & Systems Conference in Arizona, U.S., to discuss the importance of technical goals and quality management with the local supply chain. This provided an opportunity to attract talented local individuals who share the same values.

TSMC fully supports continuous improvement programs to strengthen the work culture, improve product quality and production efficiency, reduce production costs, and enhance customer satisfaction. These programs encourage colleagues to strive for excellence, drive cross-departmental observation and learning, and enhance their innovative, problem-solving abilities – all traits that greatly contribute to achieving a win-win outcome of honing TSMC's competitive edge and building customer satisfaction. To continue and uphold the excellent quality culture of TSMC, Q&R began offering quality culture courses for new employees in 2022. These courses help new employees establish the correct quality values and accelerate their integration and adaptation to their roles. In addition to internal cross-organizational learning and exchange, TSMC participates in the Taiwan Continuous Improvement Award (TCIA) to promote the development of other local industries by sharing its experience, and to enhance the problem-solving and innovation ability of its colleagues by observing improvement methods of other industries. In 2023, TSMC's outstanding performance was recognized with seven gold, two silver and two "best improvement and innovation" awards. Meanwhile, Q&R encouraged local material suppliers to participate in the TCIA for ability and quality culture enhancement, and in 2023, they won a total of nine medals: one gold, seven silver, and one bronze. Additionally, Q&R added quality courses to TSMC's Supply Online 360, sharing basic concepts of quality tools, problem-solving, and continuous improvement, as well as explaining the necessary procedures for management changes and evaluation of new materials.

Thanks to qualification in technology development, real-time defense systems and innovative applications in semiconductor manufacturing services, as well as its continuous quality improvement culture, TSMC had no product recalls initiated by customers due to safety concerns in 2023. Meanwhile, a third-party audit verified the effectiveness of the Company's quality management systems in compliance with IATF 16949: 2016 and IECQ QC 080000: 2017 requirements. In 2023, TSMC's backend fabs also continually passed the certification of American National Standards Institute ANSI/ESD (electrostatic discharge) S20.20 standard. Regular customer feedback indicates that products shipped from TSMC have consistently met or exceeded all field quality and reliability requirements. In these ways, TSMC helps customers improve time-to-market delivery and competitiveness with excellent, reliable products for the five major growth markets the Company serves: HPC, smartphones, IoT, automotive, and digital consumer electronics.

5.4 Customer Trust

5.4.1 Customers

TSMC's customers make a wide variety of products that deliver excellent performance across the semiconductor industry. They include fabless semiconductor companies, system companies, and integrated device manufacturers such as Advanced Micro Devices, Inc., Amazon Web Services, Inc., Broadcom Inc., Infineon Technologies AG, Intel Corporation, MediaTek Inc., NVIDIA Corporation, NXP Semiconductors N.V., Qualcomm Incorporated, Sony Semiconductor Solutions Corporation and many more worldwide.

Customer Service

TSMC is committed to providing customers with the highest quality service. The Company believes that excellent service is key to maintaining and improving customer satisfaction, solidifying existing customers, and attracting new customers. To this end, TSMC has established a dedicated customer service team to act as the primary contact window, facilitating seamless communication and coordination with customers in areas such as product design, mask making, wafer manufacturing, and 3DFabric® technology services, ensuring world-class service every step of the way. TSMC is committed to continuously improving customer satisfaction, earning customer trust, maintaining sales and profitability, and solidifying its role as a most reliable partner.

To improve customer interaction on a real-time basis, TSMC-Online offers a suite of web-based applications to provide more proactive customer service and support in design, engineering and logistics. Customers thus have 24-7 access to critical information. TSMC-Online facilitates design collaboration by maintaining data availability and accessibility and providing customers with accurate up-to-date information at each stage of the design process. Engineering collaboration focuses on wafer, and 3DFabric® processes, yield and wafer acceptance test analysis, as well as data quality and reliability. Logistics collaboration includes information on wafer fabrication, advanced packaging, testing, and transportation. In addition, customers can generate customized reports through TSMC-Online to meet their system automation needs.

Customer Satisfaction

To ensure customer satisfaction, TSMC must fully comprehend its customers' needs. To this end, the Company works with third-party consulting firms to conduct annual customer satisfaction surveys (ACSS) with the majority of existing customers, either via online surveys or in direct interviews. In addition to the survey, TSMC also conducts quarterly business/technical reviews (QBR/QTR) with customers to collect their feedback on a regular basis. Customer feedback is routinely reviewed, analyzed and used to develop appropriate improvement plans, all in all becoming an integral part of the customer satisfaction process. Through surveys and feedback reviews, TSMC is able to closely interact with customers, provide better services, and enhance the quality of customer collaboration.

Customer Information Protection

TSMC complies with applicable regulations and international standards to protect customer information and has received ISO 27001 international information security certification. In addition, relevant proprietary information protection policies and standard work processes are also established to ensure only authorized personnel can access the engineering and production data of any specific customer.

Customers Accounting for at Least 10% of Annual Consolidated Net Revenue in 2023 and 2022

Unit: NT$ thousands

Customer	2023			2022		
	Net Revenue	As % of 2023Total Net Revenue	Relation to TSMC	Net Revenue	As % of 2022 Total Net Revenue	Relation to TSMC
Customer A	546,550,925	25%	None	529,649,200	23%	None
Customer B	241,152,357	11%	None	N/A	N/A	None
Others	1,374,032,559	64%	-	1,734,242,092	77%	-
Total Net Revenue	2,161,735,841	100%	-	2,263,891,292	100%	-

- Reason for increase or decrease: The changes of sales amount and percentage were mainly due to customer product demand change.

5.4.2 Open Innovation Platform® Initiative

At TSMC, innovation has always been an exciting challenge. Competition continues to intensify in the face of increasing industry consolidation and the commoditization of technology at more mature, conventional levels, and thus semiconductor companies must find ways to keep innovating in order to survive and prosper. One way to promote innovation is through active collaboration with external partners. At TSMC this is known as Open Innovation®, an "outside in" approach to complement traditional "inside out" methods. TSMC has chosen this path to stimulate innovation via its OIP initiative, which is a key part of the TSMC Grand Alliance.

The OIP initiative is a comprehensive design technology infrastructure that encompasses all critical IC implementation areas to lower design barriers and improve design cycle times and first-time silicon success rates. OIP promotes the speedy implementation of innovation within the semiconductor design community and its ecosystem partners using TSMC's process technology and OIP partners' solutions in design implementation and backend services.

Crucial to OIP are ecosystem interfaces and collaborative components initiated and supported by TSMC to empower innovation throughout the supply chain and, in turn, drive the creation and sharing of new revenue and profits. TSMC's active accuracy assurance (AAA) initiative is key to OIP, providing the precision and quality required by the ecosystem interfaces and collaborative components.

TSMC's Open Innovation® model brings together the creative thinking of customers and partners under the common goal of shortening each of the following: design time, time to volume production, time to market and, ultimately, time to revenue. The model features:

- The foundry segment's earliest and most comprehensive electronic design automation (EDA) certification program, delivering timely design tool enhancement required by new process technologies.
- The foundry segment's largest, most comprehensive and most robust silicon-proven IP (intellectual properties) and library portfolio.
- Alliances that enable semiconductor designing in the Cloud for the benefit of scalability, agility and flexibility to meet various customer requirements for work models.
- Alliances that provide design services to support customer demand regarding resources and capabilities, depending on the scope and various requirements in the semiconductor design stages and value chain.
- Alliances to enable customers' system-level designs for integrating multiple chips/chiplets in 3D stacking and advanced packaging.
- Participants consisting of 14 EDA partners, seven Cloud partners, 39 IP partners, 26 design center alliance (DCA) partners, nine value chain aggregator (VCA) partners and 22 partners in the new 3DFabric® Alliance.
- A partner management portal to facilitate communication with ecosystem partners for efficient business productivity – designed with a highly intuitive interface and accessible via a direct link from TSMC-Online.

TSMC and partners work together proactively and engage much earlier and deeper than ever before in order to address the mounting design challenges of advanced technology nodes. Through this early and intensive collaboration, OIP is able to deliver the needed design infrastructure with timely enhancement of EDA tools, early availability of critical IPs and quality design services when customers need them. Taking full advantage of the process technologies once they reach production-ready maturity is critical to customer success. Hence, this helps achieve DTCO among TSMC process technologies, OIP design solutions and customer product designs.

The 2023 annual OIP Ecosystem Forum in North America demonstrated how TSMC and its ecosystem partners jointly develop design solutions on top of TSMC's advanced technologies through OIP. At the forum, TSMC made key presentations on its comprehensive 3nm technology family that continues the full-node PPA scaling trend, together with the offering of high-density and high-performance libraries and design solutions to support smartphone and high performance computing (HPC) design applications. The Company also made presentations on the readiness of analog cells that can help boost analog IP yields and analog design productivity, with the design solutions to enable EDA and design flow automation to support analog design migration. In response to the rising demand for more complex system level designs, TSMC collaborates with 3DFabric® alliance partners of 3DIC expertise in EDA, IP, DCA/VCA, memory, substrate, outsourcing semiconductor assembly testing (OSAT) and testing to provide 3D chip stacking and 2.5D advanced packaging design solutions, together with EDA tools compliant to the 3Dblox open standard to facilitate integration of multiple chips/chiplets in system-level designs using 3DFabric® technology services which include TSMC-SoIC®, InFO and CoWoS®. The availability of the aforementioned design ecosystem solutions helps customers successfully pursue opportunities in all major markets: HPC, smartphones, the Internet of Things (IoT), automotive and digital consumer electronics.

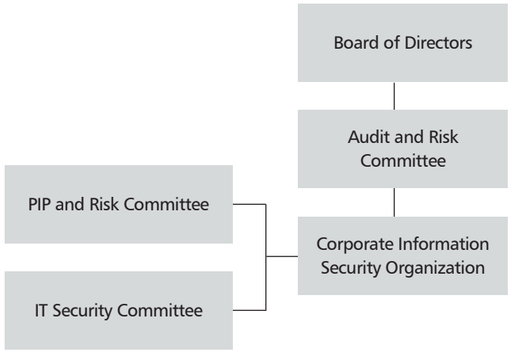
5.5 Information Security Management

5.5.1 Information Security Policy and Organization

TSMC is committed to information security and confidentiality protection for its customers, shareholders, and partners. To this end, the Company has formulated, implemented and regularly updated rigorous cybersecurity policies, procedures and measures as reflected in TSMC's Information Security Declaration.

In 2022, following the regulations of the Financial Supervisory Commission of Taiwan, TSMC appointed J.K Lin, Senior Vice President of Information Technology, Material and Risk Management, to take on the addition role of Chief Information Security Officer (CISO). Mr. Lin is responsible for the overall planning and coordination of Company resources, communicating on information security policies and directions. TSMC has established a dedicated corporate information security (CIS) organization, led by Director James Tu, to be responsible for the implementation, planning, monitoring, and management of information security. TSMC has also established the PIP and Risk Committee and the IT Security Committee to cooperate with the Company's information technology and related organizations to strengthen corporate information security protection and management mechanisms. Both committees are chaired by the CISO and comprise VP-level executives who meet regularly to review and deliberate on important information security policies as well as project implementation. Every six months, CIS executives report risk management measures to the Audit and Risk Committee, including global information security trends, corporate information security policies, plans, and implementation results. The chair of the Audit and Risk Committee also reports on the effectiveness of information security supervision and risk control measures to the Board of Directors.

Corporate Information Security Organization Structure



5.5.2 Information Security Management Strategy and Resources

To achieve TSMC's information security goals and maintain competitiveness, the corporate information security organization actively strengthens security and confidential information protection mechanisms. CIS sets clear policy, procedures and guidelines and continuously enhances the Company's management systems and implements comprehensive risk controls. In addition, CIS regularly performs information security risk assessments and sets priorities based on the impact and probability of a risk, as well as the cost of reducing such risk. CIS uses the plan-do-check-act (PDCA) methodology to continuously enhance multi-layer information security defenses and establish key performance indicators (KPIs) for information security. In 2023, TSMC invested in excess of NT$1 billion to strengthen information security, involving more than 500 employees for information security-related activities, with more than 1,000 external security personnel engaged in the physical aspects of information security services.

5.5.3 Information Security Incident Handling and Notification

TSMC has established enterprise risk management mechanisms and procedures to handle information security incidents. The mechanisms and procedures define relevant processes and measures for incident notification, designation of personnel responsible for handling material information security incidents, and assessment of losses suffered as well as additional measures needed, evaluation of information security risks to the Company's financial and operations, and proposed countermeasures to mitigate these risks. In 2023 and as of the date of this Annual Report, TSMC has not suffered any financial losses nor experienced any operational impact due to material information security incidents.

5.6 Human Capital

Human capital is TSMC's most treasured asset. The Company strives to provide employees with meaningful work, continuous learning, a safe and pleasant work environment that is both diverse and inclusive, and high-quality compensation and benefits. TSMC goes beyond this by actively encouraging employees to nurture and enjoy a healthy family life, develop personal interests, expand social participation, and, in general, live a happy life.

5.6.1 Human Rights Policy and Specific Actions

TSMC strongly believes that respecting human rights and promoting a decent work environment are vitally important. The Company is committed to supporting the following international human rights standards while complying with local laws in all operating locations, treating and respecting all personnel equally. The TSMC Human Rights Policy applies to the management team and all employees (those employed by TSMC and receiving wages or compensation), affiliated enterprises, suppliers, contractors, partners (including customers and communities), and other stakeholders committed to eliminating any human rights violations.

Management Principles

- Human Rights Governance Structure

TSMC has established a human rights governance structure with the Board of Directors at the highest level. The ESG Committee has established a cross-department human rights task force, encompassing Customer Service, Corporate Sustainability, Environmental Safety and Health, Human Resources, Information Technology, Corporate Information Security, Materials Management, Legal, Operations, Quality and Reliability, Research and Development and other functional organizations to systematically and effectively promote human rights management activities. In addition to regularly reporting progress to the ESG Steering Committee, the chairperson of the ESG Committee reports to The Nominating, Corporate Governance and Sustainability Committee under the Board of Directors on human rights management actions and implementation results.

- Due Diligence

TSMC follows the recommendations of the OECD Due Diligence Guidance for Responsible Business Conduct to carry out the Company's due diligence process. TSMC conducts the due diligence process by embedding responsible business practices into its policies and management systems, regularly identifying and assessing risks, implementing prevention and mitigation measures, and tracking mechanisms.

- Training and Advocacy

TSMC develops human rights protection training to establish awareness and develop a culture of respecting human rights. Through such training, the Company informs employees about human rights concepts and their importance, accessible grievance channels to all, and TSMC's measures for the management, prevention, and remediation of human rights violations.

- Grievance Channels

TSMC establishes robust grievance and communication channels and commits to protecting complainants. Potential human rights violations can be reported anonymously or through multiple communication mechanisms to provide concerns or suspected violations to TSMC, and the Company will initiate corresponding measures.

- Remediation

Once a human rights violation caused or contributed to by TSMC is identified, the Company will initiate a remediation mechanism based on the type of incident and, if necessary, cooperate with relevant stakeholders to prevent recurrence.

- Communication and Disclosure

TSMC identifies affected individuals on a case-by-case basis based on salient human rights issues to build a solid, trusting relationship, and listens to the voices of stakeholders through diverse, open, and two-way communication channels. The Company regularly discloses human rights management goals, actions, performance, and progress on the Company's ESG website, Sustainability Report, and Human Rights Report.

In 2023, the Company used the Responsible Business Alliance's Self-Assessment Questionnaire (SAQ) to identify the greatest risks regarding labor, health and safety, environment, and ethics matters and to formulate substantive actions and managerial response. The SAQ scores of each of TSMC's operating fabs were in the low risk range, defined as xx points or above.

TSMC conducted multiple human rights protection training courses in 2023 including plant safety and health, emergency response, first-aid personnel training, friendly workplace, etc. The total training hours are 156,595 hours, and a total of 70,576 employees have completed the training, accounting for 92% of employees. To further promote human rights, TSMC offered a course called "Understand TSMC Human Rights Policy, Create a Friendly Workplace, and Eliminate Sexual Harassment". 65,364 employees completed this training, and the passing rate of the post-training test was 100%.

TSMC abides by the rights granted to workers by laws and regulations and respects the freedom of collective consultation and assembly and association of all employees. The Company will not interfere or intervene with these activities. TSMC holds Silicon Garden meetings, aka Labor-Management meetings, on a regular basis, listens to employees' opinions and makes timely and appropriate responses through a diversified and comprehensive internal communication framework, in order to strengthen the communication between the Company's management team and employees and ensure harmonious employee relations.

5.6.2 Diversity and Inclusion

TSMC believes that a diverse management and talent structure contributes to the Company's competitive advantage and sustainable development. Through the implementation of the Diversity and Inclusion Statement, TSMC actively establishes an open management model, creates an inclusive working environment, and encourages people of varying skills and backgrounds to join the semiconductor sector, so that the industry can maximize the benefits of diverse talent resources.

To realize TSMC's People Vision and provide an inclusive workplace, TSMC has officially established three employee resource groups (ERGs), Women@tsmc, Global Family@tsmc and Accessibility@tsmc, to focus on the diversity areas of gender, race/nationality and disability since 2022-2023. In 2023, TSMC hosted the first Diversity and Inclusion Campaign, turning the Company's goals into concrete actions and promoting the innovative value of diversity and inclusion. TSMC has further expanded the scope of diversity and inclusion, planning learning structures and learning focus for different roles for all employees, aiming to support colleagues in understanding the subtleties of diversity and inclusion, including unconscious bias and how it is formed, jointly raising diverse and inclusive awareness.

5.6.3 Workforce Structure

At the end of 2023, TSMC had 76,478 employees worldwide, including 7,861 managers, 36,807 professionals, 9,235 assistants and 22,575 technicians. The following two tables summarize the makeup of TSMC's workforce and the female portion of management as of the end of February 2024:

Workforce Structure

		12/31/2022	12/31/2023	02/29/2024
Job	Managers	7,295	7,861	8,000
	Professionals	35,189	36,807	37,129
	Assistant Engineer/Clerical	8,665	9,235	9,284
	Technicians	21,941	22,575	22,620
Total		73,090	76,478	77,033
Gender	Male	65.6%	65.8%	65.9%
	Female	34.4%	34.2%	34.1%
Education	Ph.D.	3.8%	3.9%	3.9%
	Master's	47.2%	47.7%	47.9%
	Bachelor's	29.3%	29.5%	29.5%
	Other Higher Education	8.4%	8.0%	8.0%
	High School	11.3%	10.9%	10.9%
Average Age		35.7	36.2	36.2
Average Years of Service		8.3	8.7	8.8

Female Ratio in Management

	12/31/2022	12/31/2023	02/29/2024
Female Ratio in Junior Management	13.6%	14.3%	14.4%
Female Ratio in Senior Management	13.0%	13.7%	13.9%
Female Ratio in Top Management	6.1%	5.9%	5.9%

Note: Junior management positions include first-line managers; top management positions include vice presidents and higher as well as the CEO.

5.6.4 Recruitment

Sharing a common vision and values by the Company's employees is key to TSMC's growth and success. As for recruitment of new employees, the Company is committed to finding and hiring top-notch professionals in all positions. TSMC is an equal opportunity employer and practices open and fair recruitment. In addition to prioritizing integrity and ability as the primary conditions for employment, the Company also considers suitability for the position, evaluating all candidates equally regardless of race, gender, age, religion, nationality or political affiliation.

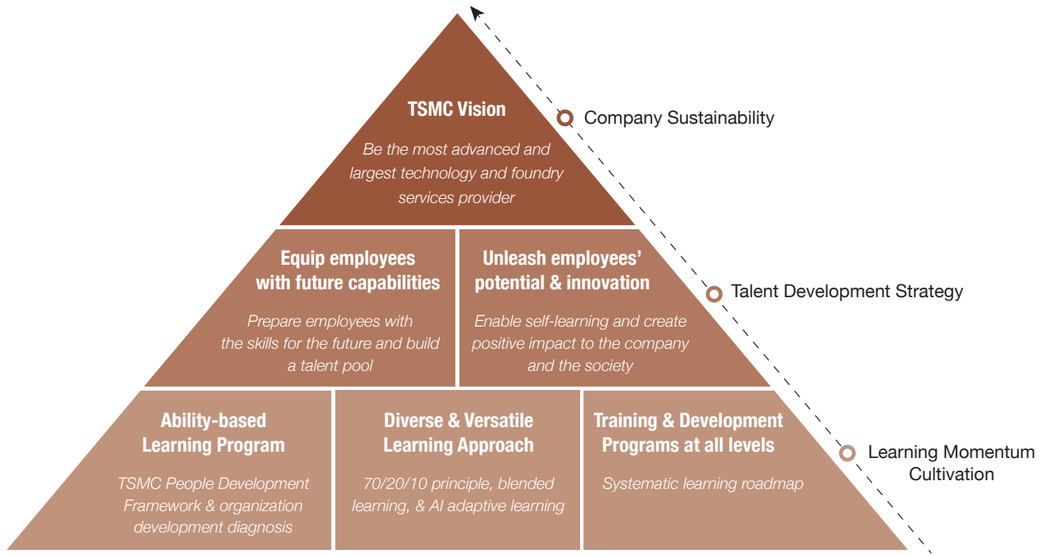
TSMC adheres to its core values and continues to move forward with a lofty vision, attracting the attention of young talents both in Taiwan and overseas. To ensure the talent it needs for the continuous growth, TSMC expanded its recruiting channels to attract top-notch professionals in all positions and employed over 6,000 employees worldwide in 2023.

5.6.5 Talent Development

Employees are TSMC's most important asset. In addition to creating a diverse and inclusive workplace that encourages employees to learn and develop their strengths, TSMC also attaches great importance to the early and continuous development of the capabilities of all employees. In this regard, the Company integrates internal and external resources, provides challenging, meaningful and interesting work in a world-class workplace and creates a continuous, diverse learning environment. In addition, the Company has initiated training and education procedures to ensure that the employees and the Company can grow together with "goals, plan and discipline" so as to become a force to uplift the society.

To pursue sustainable growth TSMC intends to expand global operations, and talent development is crucial to achieving this strategic goal. Therefore, the Company selects and cultivates talented employees based on the TSMC Talent Development Model to support sustainability and follows two strategies for talent development: equipping employees with future capabilities, i.e. preparing employees with the skills for the future and building a talent pool, and unleashing employees' potentials and innovation, i.e. encouraging and enabling self-learning and continuous innovation to create positive impacts on the Company and society. To this end, the Company initiates ability-based learning programs, focusing on the core traits of character (perseverance, resilience, initiative, innovation, judgment, broadness of mind and breadth/depth of knowledge), and further develop leadership, professional and general skills according to colleagues' different positions and professional, and the needs of Company's organization. At the same time, the Company uses a blended approach consisting of experiential learning (70%), feedback and guidance (20%), and education and training (10%). The Company also employs future AI adaptive learning, together with training and development programs at all levels, to comprehensively and systematically plan and develop the capabilities required by all employees. These approaches help cultivate learning momentum and support employees and the Company in achieving continuous growth and breakthroughs.

TSMC Talent Development Model



In 2023, TSMC conducted over more than 7,000 training sessions, more than 10,000 online courses, and provided over 6.53 million hours of training with a total in excess of 2.59 million participants. The average annual training time per employee grew to 85.4 hours, an increase of 23% over the previous year. TSMC training expense reached NT$887 million and the average training cost per employee was approximately NT$11,604, a 12 percent decrease from the previous year (Note).

5.6.6 Competitive Overall Compensation

In order to develop the most effective compensation strategies, TSMC reviews and selects benchmark companies annually and collects market information on compensation data of the whole industry for competitiveness analysis.

TSMC's compensation program includes a monthly salary, performance bonuses based on quarterly business results, and profit sharing based on annual results.

The purpose of the business performance bonus and profit sharing programs is to reward employee contributions appropriately, to encourage employees to work consistently toward ensuring TSMC's success, and to align employee interests with those of TSMC's shareholders so as to achieve win-wins for the Company, shareholders and employees alike. The Company determines the bonus and profit sharing amounts based on operating results and domestic industry practice. The amount and distribution of the employee bonuses are recommended by the Compensation and People Development Committee to the Board of Directors for approval. Individual rewards are based on each employee's job responsibility, contributions and performance.

A similar approach is used in TSMC's compensation programs at subsidiaries. In addition to providing employees with a locally competitive base salary, annual bonuses are granted as a part of total compensation, in line with local regulations, market practices and the overall operating performance of each subsidiary.

Note: In order to align the definition of training expenses with international market research information (as in *Training* magazine) to include total training spending, outside products and services, and training staff payroll, starting in 2022 the Company began including training staff payroll in annual training expenses. The change in the average training cost per employee in 2023 reflects the comprehensive impact of training manpower's business performance bonus and profit sharing and changes in the number of employees.

In addition to the competitive compensation described above, the Company approved and implemented a global employee stock purchase plan in 2022, which is available to all regular employees of TSMC and its wholly owned subsidiaries. Through this plan, employees are encouraged to participate in the Company's long-term success.

To strengthen the link between TSMC managers and shareholders' interests, the Company established corporate officer shareholding guidelines in 2020. The required holding value of TSMC shares by the chairman, CEO, and corporate officers is proportional to their annual base salary: 18 times for the chairman and CEO, nine times or three times for officers (three times is only applicable for officers hired in overseas) Officers shall fulfill the required value within three years of appointment and maintain the required value for the entire period of employment. Furthermore, to attract and retain corporate executives and other critical talent and to link their compensation with shareholder interests and environmental, social, governance (ESG) achievements, TSMC established employee restricted stock awards rules in 2021, 2022 and 2023.

5.6.7 Employee Benefit System Superior to Statute

TSMC offers employee benefits that are superior to those required by applicable statutes. In addition to twelve national holidays per year, seven memorial days are also designated as holidays. To alleviate traffic congestion during commuting hours, support family care needs, and create a diverse and inclusive workplace, the Company implemented a staggered commuting policy in 2023 and continuously optimized related flexible support. In order to support employees in practicing the Company's sustainable vision of "making society better," TSMC provides one day of volunteer leave per year since 2023. The Company provides employees with statuary labor insurance and national health insurance as well as comprehensive paid group insurance plans. Coverage includes life insurance and insurance for accidents, hospitalization, cancer, critical illness, maternity and international business travel. There are also various and unique employee self-paid group insurance plans available for employee family members. The group insurance coverage is extended to employees on approved unpaid leave. To better support new hires, TSMC offers one day of annual leave for every two months of service in the first year. Employees who need to take long leaves of absence for military service or severe injuries can also apply for unpaid leave, and then apply for reinstatement after the expiration of the period. In addition, TSMC provides pensions, financial assistance for emergencies, subsidies for marriage, childbirth and funerals, as well as discounts in designated shops.

In accordance with local laws and regulations, TSMC provides breastfeeding and breast milk collection rooms. To help employees balance their personal and work lives, TSMC not only offers parental leave but also provides a comprehensive leave management system. To further create a family-friendly workplace and support for TSMC employees' parenting needs, starting from October 1, 2023 the Company implemented the TSMC Childcare Benefit Program 2.0, to extend maternity leave for second birth from 12 to 16 weeks and third birth from 16 to 20 weeks. The maternity subsidy increased to a maximum of NT$20,000 (NT$10,000 from employee welfare committee and maximum NT$10,000 maternity insurance). TSMC has set up four onsite kindergartens for employees in Taiwan. In addition, a holiday STEAM (science, technology, engineering, art and math) campus has been organized for employees' children.

All TSMC facilities are equipped with 24-hour health centers, where healthcare management professionals and appointed onsite physicians provide quality services beyond those required legally. The health centers work with hospitals and employee assistance program service providers to offer comprehensive support for the emotional and physical well-being of employees. In addition to annual checkups for all employees, in 2023 TSMC began providing employees with five advanced checkup items upon completion of every five years of service. The Company encourages employees to exercise regularly by subsidizing 65 clubs, improving exercise facilities, and holding regular sports events to help employees find peers with similar sports interests. Also, to help employees balance their work and life, TSMC provides:

- Convenient onsite services and amenities such as in-fab cafeterias, convenience stores, and other services
- Comprehensive health management services, including in-fab clinic services, post health-exam follow-up activities, and employee assistance programs
- Diverse employee welfare programs, leisure and art events, hobby clubs, vibrant sports centers and onsite preschool services to meet employees' needs for childcare, festival bonuses and emergency subsidies if and when needed

Vacation and insurance policies at TSMC's overseas offices are designed to be in compliance with local regulations. In China, North America and Europe, TSMC provides more vacation days to employees than legally required. In overseas offices, TSMC offers a more comprehensive life and medical insurance than required by local regulations and customs.

5.6.8 Diverse Employee Recognition

TSMC sponsors various internal award programs to recognize employees for outstanding achievement, both individual and at a team level. With these award programs, TSMC aims to encourage continued employee development, which also enhances the Company's competitiveness.

The award programs include:

- TSMC Academy to recognize outstanding scientists and engineers whose individual technical capabilities have made significant contributions
- TSMC Excellent Labor Award to recognize technicians whose outstanding performances have made significant contributions
- Total Quality Excellence to recognize employees' continuous efforts in creating value at each fab
- Service Award to recognize and show appreciation of senior employees for their long-term commitment and dedication
- Excellent Instructor Award to praise the outstanding performance and contribution of internal instructors of training courses for employees

Apart from the recognitions above, there are function-wide awards dedicated to innovation, such as the Idea Forum, the Total Quality Excellence Award and the ESG Award, which recognize employee initiative and continuous implementation of innovative practices. In addition, TSMC encourages employees to participate in external talent activities and competitions. In 2023, distinguished TSMC employees continued to be recognized through a host of awards, such as the Model Labor Award, the Excellent Young Engineers Award, the Outstanding Engineer Award, the Taiwan Continuous Improvement Awards, the National Manager Excellence Award and the National Industrial Awards.

5.6.9 Employee Engagement

The Company encourages employees to maintain a healthy and well-balanced life while pursuing their career goals effectively. TSMC facilitates employee communication and provides employee caring, benefit, rewards and recognition programs.

Employee Communication

TSMC values employee communication and is committed to keeping communication channels open and transparent between managers and employees, and amongst peers. The Company is committed to ensuring that employees are able to communicate openly and share ideas and concerns with management regarding work conditions and management practices without fear of recrimination, reprisal, intimidation or harassment. TSMC makes continuous efforts to listen to employees and to facilitate mutual and timely employee communication, through multiple channels and platforms, which in turn fosters harmonious labor relations.

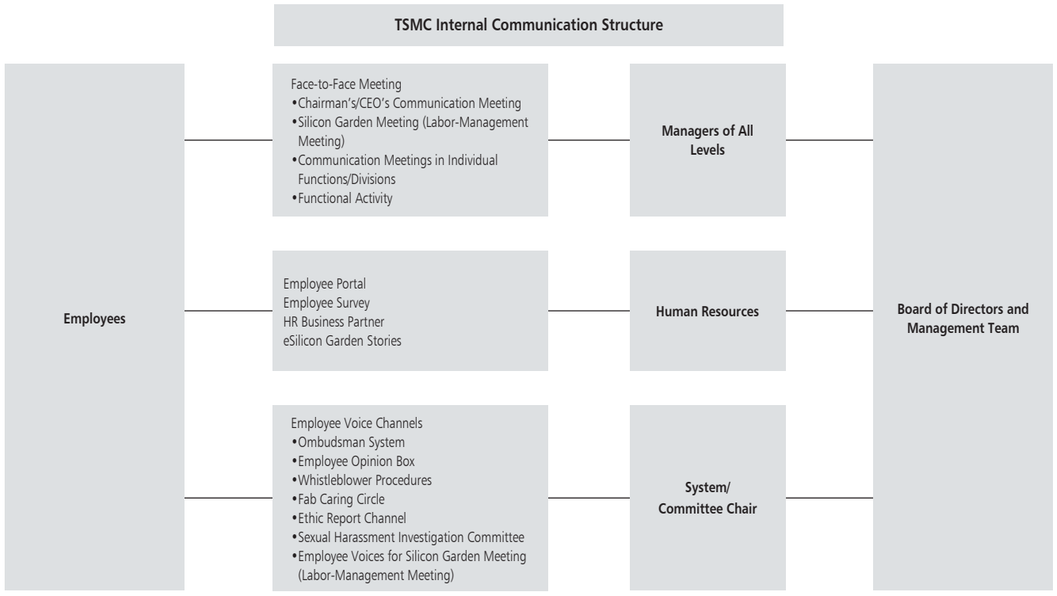
TSMC conducts biannual face-to-face CEO dialogue sessions in Hsinchu, Taichung, and Tainan, which allows the employees to make suggestions, express their thoughts and get direct feedback from the CEO. In addition, the Company has also enlarged the scope of the labor-management meeting, transforming it into the Silicon Garden Meeting, which helps all employees feel free to put forward their ideas so the Company can take appropriate action.

TSMC supports a host of various communication channels including:

- Communication meetings for various levels of managers and employees, e.g. the executives communication meeting, skip levels and communication meetings in individual functions/ divisions
- Quarterly Silicon Garden meetings, aka Labor-Management meetings, to provide business updates and discuss issues of concern for employees
- The biennial employee survey on core values taken to understand the Company's implementation of core values and employee commitment
- The biennial global employee engagement survey taken to systematically understand the work experience of employees and to enhance employee engagement and sense of belonging in the Company

- Periodic employee pulse surveys and service satisfaction surveys given to selected employees with follow-up actions based on survey findings
- *myTSMC* employee portal, an internal website featuring talks by the Founder, the Chairman and the CEO, corporate messages, executive interviews, and other topics of interest to employees
- e*Silicon Garden Stories*, TSMC's newsletter providing real-time updates on major activities of the Company as well as inspirational content featuring outstanding teams or individuals
- Three channels for reporting complaints regarding managerial, financial, auditing, ethics and business conduct issues:
  – The whistleblower reporting system, administered by the Audit Committee
  – The irregular business conduct reporting system, administered by the Ethics Committee
  – The ombudsman system administered by a senior manager, appointed by the CEO
- The Employee Opinion Box, which provides an opportunity to submit suggestions or opinions regarding work and the work environment
- The Fab Caring Circle in each fab, which addresses issues related to employees' work and personal life – dedicated mainly to the Company's direct laborers
- The sexual harassment investigation committee, a channel dedicated to ensuring a work environment free from the threat of sexual harassment; the committee consists of three directors appointed by the CEO, one from human resources, one from legal affairs, and the third from another organization

Employee Communication Channels



During 2023 and as of the date of this Annual Report, TSMC has not incurred any labor-dispute related losses. However, the Company was fined for the following labor inspection results: NT$100,000 issued on 04/26/2023 for the extension of working hours combined with the regular working hours exceeding permitted limit (Labor Standards Act Article 32 Paragraph 2). NT$100,000, and NT$50,000 issued, respectively, on 05/19/2023 for the extension of working hours combined with the regular working hours exceeding permitted limit, and inadequate rest time of a minimum of 12 hours after the occurrence of an emergency or unexpected event (Labor Standards Act Article 32 Paragraph 2, and Paragraph 4). NT$300,000 issued on 08/07/2023 for the extension of working hours combined with the regular working hours exceeding permitted limit (Labor Standards Act Article 32 Paragraph 2). NT$350,000 issued on 08/18/2023 for the extension of working hours combined with the regular working hours exceeding permitted limit (Labor Standards Act Article 32 Paragraph 2). NT$150,000 issued on 09/26/2023 for the extension of working hours combined with the regular working hours exceeding permitted limit (Labor Standards Act Article 32 Paragraph 2). NT$150,000 issued on 10/03/2023 for the extension of working hours combined with the regular working hours exceeding permitted limit (Labor Standards Act Article 32 Paragraph 2). NT$400,000 issued on 02/07/2024 for the extension of working hours combined with the regular working hours exceeding permitted limit (Labor Standards Act Article 32 Paragraph 2).

The Company has reviewed its working hour management process and established indices to remind employees to apply for overtime payment on time and for mangers to respond to such applications efficiently and in a timely fashion, and to be more diligent about employee working hours as well as to strengthen communication about these matters and relevant policies.

5.6.10 Retention

In 2023, TSMC conducted its second global employee engagement survey (EES), based on High Performance Employee Experience Model (Note) to maintain comparability with 2021 EES data. The survey aimed to understand the strengths and opportunities for continuous improvement in employee experience at TSMC and to develop action plans that retain talent. The survey participants included global TSMC employees and its subsidiaries, except for VisEra due to its different industrial background. Overall, 65,123 employees participated in the survey, representing 89% of all TSMC employees.

Based on the survey results in 2023, TSMC is perceived by its employees as possessing strong competitiveness in the market, exhibiting agility in responding to market changes, and being adept at delivering innovative products and services that create value for its customers. TSMC will continue to enhance the following 3 aspects:

- Encourage colleagues to proactively share their ideas through an open management model in order to create a mutually respectful environment.
- Enhance colleagues' sense of belonging and achievement by unleashing their potential, allowing them to enjoy their work, continuously learn, and grow.
- Motivate and retain talent by providing more non-monetary rewards.

TSMC's turnover rate was 3.7% in 2023 compared to 6.7% in 2022, both within a healthy range of less than 10%.

5.6.11 Retirement Policy

TSMC established its statutory defined benefit plan and supervisory committee of labor retirement reserve according to the Labor Standards Act, and also set up its statutory defined contribution plan according to Labor Pension Act, which became effective starting July 1, 2005. For each region, TSMC also established pension plans according to local standards and regulations. The previously mentioned supervisory committee not only holds quarterly meetings but also supervises affairs in connection with labor's retirement reserve fund. To meet legal requirements for disclosure of financial reporting and ensure sufficient funding levels, TSMC makes contributions based statutory requirements and also engages an actuarial consulting firm to assess the valuation of the defined benefit plan. Please refer to page 45-47 of the attached financial report for details. Thanks to the Company's sound financial condition, it is able to ensure the future viability of employee retirement benefits and solid pension contributions and payments, which encourages employees to make long-term career plans with and further deepen their commitment to TSMC.

5.7 Material Contracts

TSMC is not currently a party to any material contracts, other than those entered into in the ordinary course of its business. The Company's "Significant Contingent Liabilities and Unrecognized Commitments" are disclosed in Annual Report section (II), Financial Statements, page 73.

Note: Based on Willis Towers Watson's "High Performance Employee Experience (HPEX) Model".