

4 Innovative technology

P51. R&D and Innovation

P55. Customer Service

The Best Partner for Our Customers

"Innovation" is one of the driving forces for Nanya's growth and competitiveness and one of our four core values. We shall strengthen product research, development, and manufacturing to satisfy customers' diverse demands and become the best memory partner for the smart generation.

8.4%

R&D expenses accounted for 8.4% of revenue and R&D personnel accounted for 26.0% of employees. These demonstrate Nanya's focus on technological development.

93.7 points

The customer satisfaction score was 93.7 points, reaching the target of 90 points set for the year

207 cases

Rewards for improvement proposals reached 207 cases, showing that employees adapted well to the culture of work improvement.



Strategies and Performance

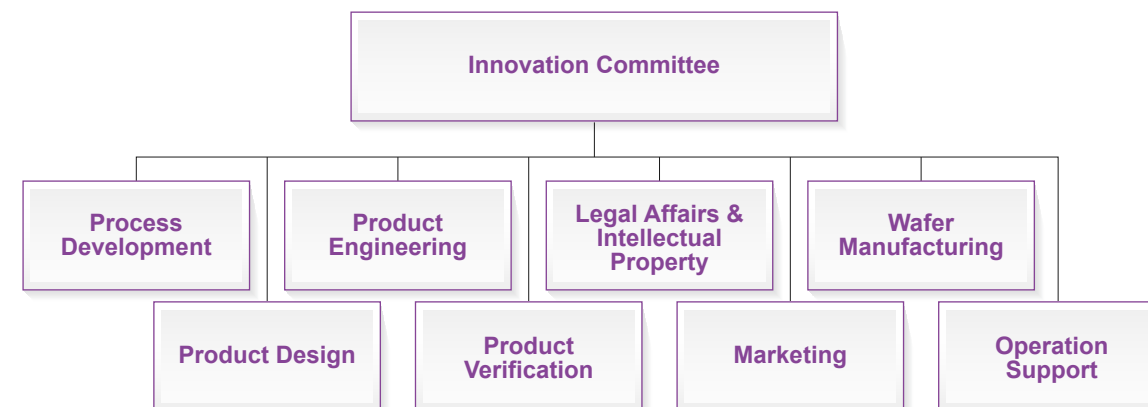
2021 Goals	2020 Goals	2020 Performance
R&D and Innovation Design new next-generation products, Develop 10nm process technologies, Entered the high-density server module market, Smart factory		
Complete the verification of 10nm DRAM technology for product shipment	Established 10nm DRAM technology	Completed the establishment of 10nm DRAM technology with quality standards conforming to product testing criteria
Train and equip a total of 400 engineering personnel with AI theories and practical technological capabilities	Establish high-performance production lines with AI-assistance and reach a project completion rate of 70%	Trained and equipped a total of 300 engineering personnel with AI theories and practical technological capabilities; completed 50 items for intelligent system development at the same time, reaching a project completion rate of 70%
Complete 70 items for intelligent system development	Completed product designs of 1A DDR4, LPDDR4, and DDR5	<ul style="list-style-type: none"> Completed the product design of 1A-nm LPDDR4, and carried on the trial production The product design of 1A-nm DDR4 was estimated to be completed in Q1 2021. The product design of 1A-nm DDR5 was estimated to be completed in Q2 2021.
Customer Service Design and testing: Use global engineering support services to resolve issues with customer design and testing. Production and sales: Implement rigorous control of quality and improve delivery efficiency. After-sales services: Use the customer complaint management system to quickly resolve customers' issues		
Customer satisfaction score: Over 90 points	90 points	93.7 points
Customer participation in platform parameters measurement services: 930 cases	920 cases	955 cases
Joint product verification services for customers: 24 cases	24 cases	27 cases
Customer technical exchange and courses: 80 sessions	80 sessions	91 sessions

R&D AND INNOVATION

Smart products have been completely improving the quality of life for human beings and helping energy conservation and carbon reduction. Therefore, every year, Nanya invests large amounts of resources in technological development of new types of DRAM products, next generation processes, and advanced 3D stacked packaging. The developments provide customers with value-added services, and reinforces protection for intellectual property and trade secrets, accelerating the move towards product diversification and smart factories. Moreover, we have set a vision for innovative development to introduce the second generation 10nm DRAM process into mass production in 2025, develop the third generation 10nm DRAM process and the next-generation DDR5 and LPDDR5 products, and manufacture 16Gb high density products at large scale so as to enter fast-growing markets (artificial intelligence (AI), data centers, automotive and the Internet of Things), and set up high-efficient production lines with an AI-aided system.

Innovation Committee

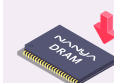
In order to implement innovation management, create a culture of innovation, and enhance the company's innovative energy and value, Nanya especially set up the Innovation Committee, a cross-departmental unit, formed by the senior management and chaired by Executive Vice President (EVP). The Innovation Committee is positioned to coordinate and plan the overall innovation strategy, setting short, medium and long-term goals. The committee holds regular meetings to review the progress of various major projects. In 2020, we successfully completed the establishment of 10nm technology with quality standards conforming to product testing criteria, we also completed the product design of the first generation 10nm DRAM at the same time. On the aspect of AI, we cultivated and equipped a total of 300 technical specialists with theories and practical experiences, and developed 50 items for intelligent system.



R&D of Low Energy Consumption Products

It is at the stage of new product development that the company starts considering the impacts on environment incurred by product life cycles, actively researching and developing new-generation low energy DRAM products so as to reduce energy consumption of end electronic products and lower greenhouse gas emissions. If different applications of electronic products were used as the basis to measure the energy consumption of our low power DRAM products sold in 2020, we saved approximately 658.48 million kWh on electricity consumption per year, and reduced CO₂ emissions of 335,164 tons annually, making concrete contributions to our expansion of business operations and our efforts to maintain a green earth.

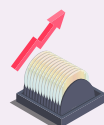
R&D Policy for Low Energy Consumption Products



Nanya continues to develop advanced manufacturing processes, so the energy consumption of new generation products developed with new processes is reduced by 15% compared with the previous generation.



Nanya cooperates with major chip customers, adopting the method of multi chip package (MCP) to reduce back-end assembly and testing as well as energy consumption.



Nanya strengthens the development of low energy consumption product lines and enlarges product portfolios in order to satisfy the need of various mobile devices and electronic products.

Investment in Innovative R&D

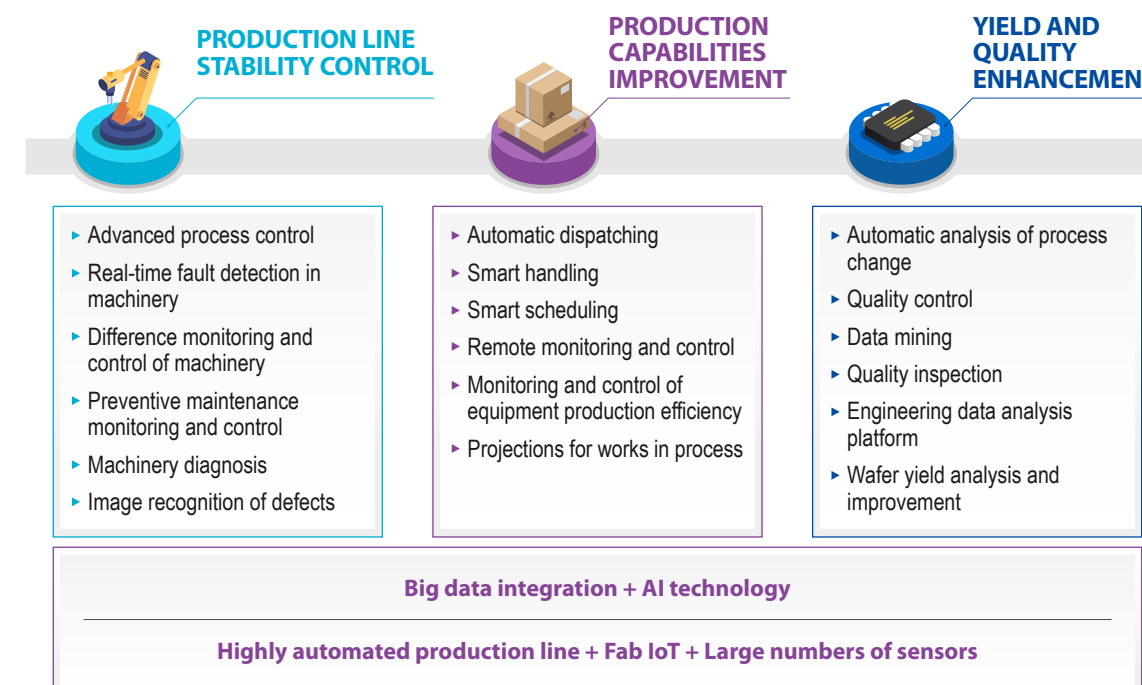
2017	2018	2019	2020
Operating revenue (A) (NT\$100 million)			
549	847	517	610
Budget for innovative R&D (B) (NT\$100 million)			
36.7	48.9	49.3	51.4
Percentage of revenue for allocated to innovative R&D (B/A)			
6.7%	5.7%	9.5%	8.4%
Total number of employees (C)			
2,984	3,219	3,307	3,542
Total number of innovative R&D personnel (D)			
430	501	639	922
Percentage of innovative R&D personnel among all employees (D/C)			
14.4%	15.5%	19.3%	26.0%
Output of Innovative R&D			
Number of patents awarded			
471	502	459	438

Nanya Smart Factory

Nanya's 12-inch wafer fabrication plant has all the necessary infrastructure that a smart factory requires, including highly automated production lines, Fab IoT, large numbers of sensors, big data integration, and AI technology. Currently, the company has developed a number of innovative production line applications, including the machinery diagnosis, advanced process control, optimization of production schedules, projections of work in process, smart handling, wafer probe testing, defect image recognition, and pattern recognition of wafer yield. These applications can effectively enhance the entire operational efficiency of production lines. Because of these developments, three important aspects of production, i.e., yield, quality, and output, are benefited.

With increased difficulties in new-generation advanced processes, higher process precision is required. Moreover, diverse product portfolios have increased the complexity of line control. Nanya has actively implemented AI technologies to drive progress, hoping that each part of operations can be more efficient; engineering teams can be more insightful; and plants operations can generate more value. With the gradual implementation of AI technology in various major operational settings in the plants, high-performance production lines with AI-assistance are going to be established, so the overall efficiency and capacity of processes will be enhanced.

Nanya smart factory - infrastructure and three major applications



Status and Strategy of Intellectual Property

Nanya has created many patents through the cooperation with world-class entities, technology transfer, and joint execution of R&D plans, and has acquired these patents. As of 2020, Nanya has obtained as many as over 4,000 patents, which is hugely beneficial to R&D and production. Meanwhile, in relation to the protection of our trade secrets and trademarks, we have also established a complete protection system. In regard to continuous profitability and risk prevention, we have established complete operating mechanisms in order to protect proprietary R&D results and consolidate our competitive advantages. Moreover, we can flexibly use intellectual property to effectively resist excessive patent litigation.

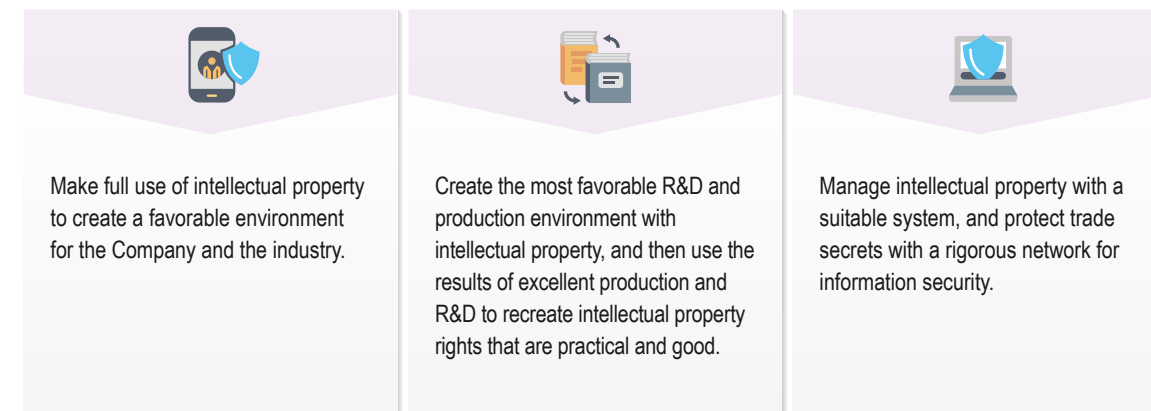
Critical legal cases related to intellectual property involving Nanya were as follows:

In October, 2016, Lone Star Silicon Innovations accused Nanya and its subsidiaries (collectively "Nanya") in the U.S. District Court of East Texas for patent infringement. The case was transferred to the U.S. District Court of Northern District of California in July, 2017 and the Court adjudicated the dismissal of the case in January 2018. The Plaintiff is appealing against the dismissal to Federal Court and State Court, and Nanya has engaged counsels to properly handle it to ensure Nanya's rights.

The U.S.-based Monterey Research LLC. accused Nanya and subsidiaries Nanya Technology USA and Nanya Technology Delaware in the U.S. District Court for the District of Delaware for patent infringement in November 2019. We have engaged counsels to properly handle the case to protect our rights and interests.

[Intellectual Property Management](https://www.nanya.com/en/IR/111/Intellectual%20Property%20Management)
<https://www.nanya.com/en/IR/111/Intellectual%20Property%20Management>

Nanya intellectual property strategy

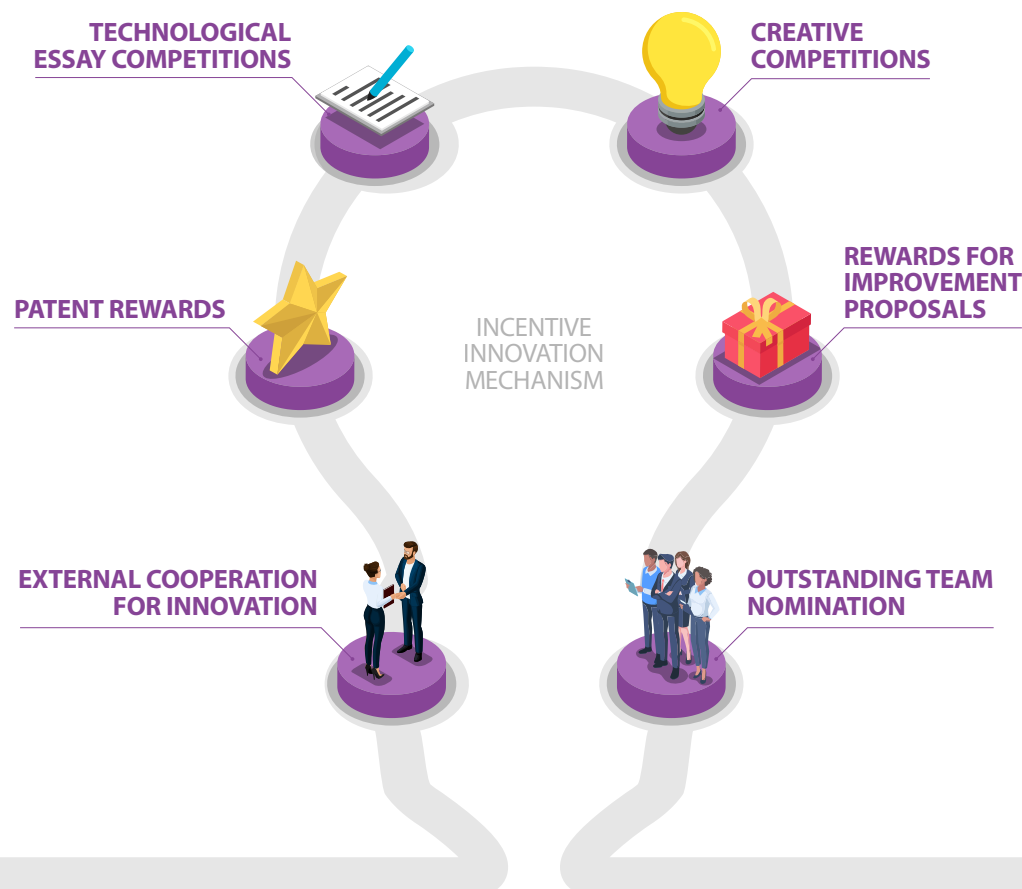


In addition, in the face of increasingly intense business competition and challenges of globalization, the protection of trade secrets has become an increasingly important subject for an enterprise to maintain its core competitiveness. Trade secrets include technology, methods, processes, recipes, programs, and design or other information that can be used in production, sales or operation, complying with the requirements for secrecy, economic value, and confidentiality measures that have been taken. In recent years, Nanya has actively implemented advanced process technology, new product development, and innovative sales models. In order to ensure the Company's long-term competitive advantages, we implemented the ISO 27001 Information Security Management system in 2019 and continuously obtained external verification in 2020 so as to minimize the risk of leaks.

2017	2018	2019	2020
Number of trade secrets			
4,172	5,056	3,989	4,031

Incentives for Innovation

"Innovation" is one of the driving forces behind the company's technological growth and competitiveness enhancement and one of our core values. To encourage employees to propose innovative ideas, the Company holds annual innovation competitions, offers patent rewards and rewards for improvement proposals, and organizes essay competitions and the best team competitions. We recognize and reward innovative ideas proposed by each employee, hoping that all employees will internalize the spirit of innovation. Results of activities held in recent years were shown in the table below.



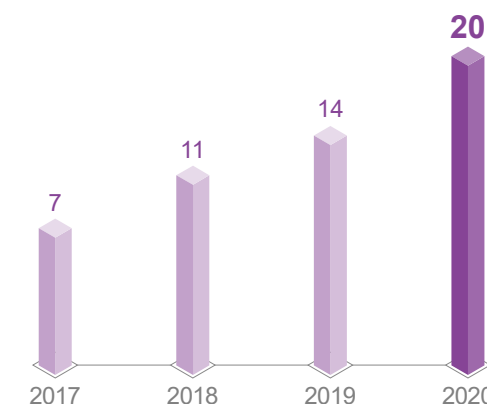
Results of innovative activities

	2017	2018	2019	2020
Patent rewards - Number of patents granted	471	502	459	438
Rewards for improvement proposals - Number of proposals	47	51	225	207
Rewards for improvement proposals - Actual annual benefit (NT\$)	158,563,200	311,059,200	368,721,600	1,583,318,400
Technological essay competitions - Number of entries	46	58	65	79
Best team competitions - Number of entries	7	15	15	17

In addition, we have attached great importance to technological R&D. We incorporate external innovation into our R&D in open and innovative ways, so the Company can maintain sustainable development. We have worked on the design and basic research of next generation memory with professors from National Taiwan University, National Central University, and Chang Gung University, and the Electronic and Optoelectronic System Research Laboratories under the Industrial Technology Research Institute. We have also partnered with manufacturers of masks and machinery in joint development of next generation DRAM process and materials. Through customized Wafer Level Packaging and multiple application products developed rapidly with downstream system developers, Nanya has launched new open innovation programs every year in the past four years in order to conform with the Company's short, medium, and long-term R&D plans.

Open innovation program

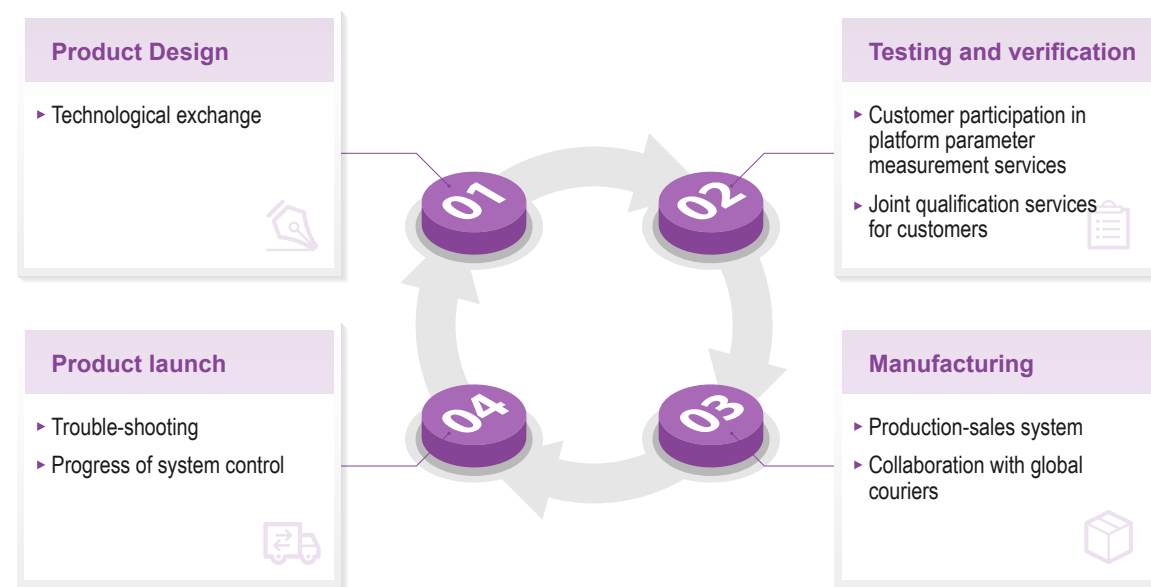
Unit : Number of cases



CUSTOMER SERVICE

Nanya is committed to providing the best customer service and is convinced that quality and timely customer service is crucial to the maintenance of customer relationships. Good customer relationships will help us build customer loyalty, and consolidate the good and trusted partnerships with customers. Our vision is to become the best memory partner in the smart era as well as a service-oriented enterprise. Through close cooperation with MCU makers and customers, we will strengthen product R&D and manufacturing in order to satisfy diverse requirements, provide customers with comprehensive products and system solutions, and offer better and more trustworthy service.

Customer Service Process



Product Design and Testing Verification Stage

In order to improve the efficiency and frequency of customer service and effectively build close relationships with customers, the Field Application Engineering Division provides technical supports to customers in Taiwan, China, Southeast Asia, Europe, the United States, Japan and South Korea, organizing irregular technology exchange events to meet the technical needs of customers. In 2020, the Division held a total of 91 events, providing technical supports and assisting customers' engineering personnel to solve problems in design and testing.

In addition, through the highly efficient, intensive, and high-quality customer platform parameter measurement service, of which 955 cases were completed in 2020, Nanya assisted customers in understanding the characteristics of their product platforms so that the new product development progress and verification cycles of customers were significantly accelerated, reducing investment risks and helping final products to be launched in a timely manner in the demand market. Nanya also provides joint qualification services for customers to assist them in development and verification at the initial stage of products. Therefore, compatibility issues may be detected early, and improved before mass production. A total of 27 cases were completed under the joint verification services in 2020.

Production and Sales Stage

Nanya has been certified for ISO 9001: 2015 and IATF 16949: 2016 quality system. The Quality Assurance Division monitors and controls product quality as well as implements improvements in order to make sure that all production processes are fully optimized. Moreover, the Division includes each stage of the production process into a well maintained and tightly controlled system, manufacturing the products that meet the customers' requirements. The sales staff continuously communicates with the customer and sends the weekly projections of the customer's future demand forecast back to the Company. The Company's production and sales system converts the information into a production plan after the head office aggregates the needs of global business feedback and the plan is adjusted according to the weekly feedback from sales staff so as to meet customer needs.

After-sales Service Stage

Nanya is committed to enhancing product quality and rapidly responding to customers' quality issues to meet their expectations. In order to accelerate the efficiency of problem analysis, the Nanya's service team will fully understand the problems reported by customers first, update analysis progress to customers based on analysis plans, and send customers the corrective measures and handling methods once analysis is completed. Through the cooperation among the divisions of Field Application Engineering, Quality Assurance, Product Engineering, and Manufacturing Process along with the process management conducted with a customer complaint handling system, over the years, the company has been able to reply to over 90% of customers' complaints within target deadlines.

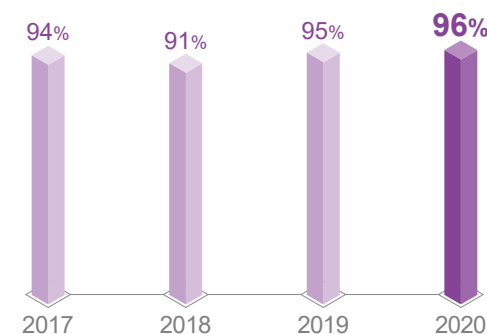
Customer complaint handling process



Achieving rate of customer complaint cases

In 2020, Nanya completed 96% of customer complaint cases within target deadlines. The Company will continue to maintain frequent communication with customers and understand how customers use our products and failure conditions in the shortest time possible to accelerate problem analysis and solve problems.

Achieving rate of customer complaint cases



Customer Privacy Protection

Customers are extremely important partners for the company. Therefore, we are obligated to rigorously safeguard their privacy and confidential information as if it is our own. To ensure confidential information is well protected, Nanya has formulated the Confidential Information Management Procedure. Regarding the documents provided by customers, after internal filing procedure and the confidentiality classification, these documents are archived in the document control center. In the future, if employees require access to these documents, they have to go through the document application procedure. Based on the level of document confidentiality and the purpose of use, corresponding supervisors give their approval and then the document control center will authorize the access and distribute the documents to the applicants. In 2020, no case involving violation of customer privacy occurred. If a customer suspects or discovers evidence indicating an information leak, a complaint can be lodged through the NTC Complaint Mailbox and Complaint Hotline.

Customer Satisfaction

Nanya strive for continuous improvement, working in a practical way, with a spirit based on exceeding our customers' requirements in quality, delivery and service. In relation to customer satisfaction, Nanya employs an impartial third-party consultancy company to conduct satisfaction survey for direct and end-customers through the internet or interviews, that Nanya can understand customers' needs from a fair and objective perspective. The content of the survey includes the dimensions of "Product", "Delivery", "Quality", "Technical service", "Communication", "Commercial" and "Comparison with competitors". With regard low performance items, relevant departments are responsible to review and proposed corrective action. In addition, the results of customer satisfaction survey are submitted and reported at the top management meeting, while the sales personnel are going to reply customers with improvement results or continuous improvement plan, and continue to improve customer satisfaction. In order to improve customer satisfaction, Nanya has established a review platform to give priority to handle and improve customers' requirements.

In addition to the customer satisfaction survey, customers regularly conducts business and technical review meetings with Nanya's service team, Nanya is able to keep close relationships with customers and provide better service. We will commit ourselves to strengthening the collaborative cooperation among internal relevant divisions in response to urgent or sudden demands from customers. Moreover, we will continuously strive to improve product quality and the timeliness and efficiency of communication on quality issues with customers while keeping smooth communication with customers, making every effort to satisfy customers' requirements.

Customer Satisfaction Survey Procedure



The average overall satisfaction score of 2020 was 93.7 points, reaching the target of 90 points. In the last three years, our customer satisfaction has gradually increased and the target score for 2021 is 90 points and above. The target setting of the customer satisfaction survey is to consider the fluctuation of the industrial characteristics and the annual regular review of the performance and benchmarking, and set a reasonable target, submitted to the president for approval by the quality assurance division.

In regard to the Nanya's scores and the results of comparison with competitors, customers highly recognize the Nanya's performance on delivery, technical service and communication, Mainly Nanya assists the client in accelerating the verification of new products and technical exchanges during the product design, testing and verification phase. In addition, there is still room for improvement in the performance of product technology capabilities and quality. Based on the supply and demand of the market and product application, we will strengthen customer communication and improvement with positive attitude, insisting on product quality control and improvement according to customers' feedback. Thus, in 2020, there were no product recalls.

Results of Customer Satisfaction Survey

