

Industry Report

MEM MARKET IN SOUTH KOREA



OFFICIAL PROGRAM



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MEM MARKET IN SOUTH KOREA

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1. Foreword

The Republic of Korea lived through a tremendous industrial growth in the last fifty years. In the early sixties, Korea was among the five poorest countries on the planet with a GDP per capita below USD 100. Today, the country boasts the 11th largest economy in the world and is the 5th largest exporter. The main markets for Korean exports are China and the US, followed by Vietnam. The latter will overtake the US as an export market around 2020 when the export value to Vietnam will hit the USD 100 billion mark. Given the export power of Korea, it is of utmost importance to consider this market from a global supply chain perspective.

This report highlights three promising areas in Korea's MEM industry; machine tools, 3D printers, and the robotics industry.

The demand for machine tools has increased while imports have been declining due to the technological growth of Korean companies. Swiss exports have grown over the years, especially in machining centers. It is reported that the mid-high level of machining centers for milling, turning centers for turning and high-speed machining systems are now seeing more opportunities.

In the 3D printing market, the localization rate of products and technologies is only about 10%. There are important opportunities for Swiss companies in the market, although the market is still in its infancy.

Korean manufacturers are global leaders in robot density, utilizing more than 500 multipurpose robots per 10'000 manufacturing employees. Korea is an aging society and labor shortage will increase in the future. Due to the global demand of semiconductors and displays, massive investment in production capacity is needed. The only way to stay competitive in such an environment is to get yet on a higher level of automation. Industry 4.0 and Smart Factory approaches are recognized as absolute game changers. Advanced manufacturing technology from Switzerland stands a good chance to successfully compete in this growing market.

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2. Executive Summary

This research reports the current status of three essential areas of MEM industry; machine tools, 3D printers, and the robotics industry. It focuses on high-speed multi-tasking machining systems within the machine tool category. For each area, it investigates market figures, the business environment in four aspects, and explains major market players, to help promote the understanding of the entire industrial environment.

The Korean machinery industry has declined in respect to imports and exports, except for the machine tool industry. It is expected to grow at a CAGR of 9.46% until 2019, and its size is expected to reach about CHF 16 billion. Thanks to the growth of the Korean automobile, electronics, and machinery industries, the demand for investment of equipment and facilities in these fields is also skyrocketing. It is known that the semiconductor industry and the display industry are leading Korean facility investment, and particularly the semiconductor industry invested about USD 40 billion in 2017.

The machine tool imports from Switzerland reached as much as USD 82 million in 2016, about 7% of total imports. Many Swiss machine tools are sold in the category of the high-speed multi-tasking machining system sector, such as CNC machining centers. In the future, machine tools are expected to generate added value in the direction of complexity, hybridization, and intelligence. Due to the demand of customers' product changes with small quantity batch production from mass production, Swiss companies should pay attention to this trend in Korea. In mid to long term, it is important to focus on industries such as aerospace, medical and biotechnology where the production of small quantities of products will be the primary focus.

High-speed multitasking machining systems are being used to achieve the goal of maximizing the efficiency of the machining process. This market holds the largest portion of the entire machine tool market. As of 2019, it accounts for about 50%, and it is growing faster than the growth rate of the entire machine tools market (9.46%). In relation to high-end products such as precision machining equipment and grinding machines, Japan, Germany and Switzerland are competing in the Korean market, where sales of Korean domestic products amount to 31%. This report also describes the demand for high-speed multitasking machining system technology in more detail in Chapter 4.

As the production of small quantities of various items is expanding, it is expected that there will be more demand for the parts made by cutting with machine tools or by printing with additive manufacturing than the parts made in molding. Therefore, the possibility of 3D printing is high in future, although the current market is in its early stage.

The Korean robotics market is expected to grow to as much as CHF 4 billion by 2019. The application of industrial robots in Korea is ranked second in the world by utilizing about 40,000 robots in 2015. This is the second largest such usage in the world, but it is the world's largest robot density (the number of industrial robots per 10,000 workers), which relates to robot dependence in the industry. In the future, the number of smart factories is expected to increase further due to developments in the Internet of Things and cloud computing, therefore, the industrial robot market in Korea is expected to grow further. In particular, demand for collaborative robots that work with humans in the industrial field is expected to increase.

We have interviewed several Swiss MEM product importers to ascertain the difficulties or obstacles for importing. There are two points indicated by them; 1) the reputation of Swiss products is excellent, but complaints about additional services after sales are relatively big, compared with local Korean and Japanese companies. Swiss companies ought to build a business system that can help to overcome geographical weaknesses; Japanese companies perform quicker when handling warranty and after sales service. 2) Swiss companies are required to maintain business relationships more closely with local Korean partners. For example, they want Swiss companies to be more supportive in dealing with administrative aspects in trade such as utilizing Korea-EFTA FTA for tariff exemption.

It is possible for Swiss companies to participate in the public procurement system in Korea. Since there are various variables in the process of bidding, delegation to a Korean agent for applying for the bid will reduce costs and increase efficiency. Basic information has been provided to participate in the public procurement market in Korea, in the appendix of the report.

3. Korea Industries Prospects in 2018

Korean industry in 2018 is expected to increase in production and exports due to the increase in demand for general machinery, which is the traditional flagship industry. The semiconductor industry is expected to remain favorable, the display industry to grow at a similar level to the previous year, and the mobile phone industry to increase in both production and exports. However, the shipbuilding and shipping industries are expected to remain sluggish. Due to the recovery of the global economy and the economic boom, massive investments are being made in semiconductor factories and display factories centered on Samsung Electronics and LG Electronics.

In 2017, the Korean economy was driven by investment-led growth starting in 2015. Over the past two years, investment contributed more than 50% to growth and exceeded 80% in 2017. Construction investment contributed to growth continuously, but facility investment made a big contribution in 2017. However, the growth momentum of the domestic economy was gradually slowing as the vitality of the investment weakened in the second half of 2017.

Korea's industry in 2018 is expected to increase in production and exports due to the increase in demand for general machinery, which is the traditional flagship industry. In the ICT industry, the semiconductor industry is brisk, the display industry is expected to show growth similar to the previous year, and the mobile phone industry is expected to increase in production and exports due to base effect. However, the shipbuilding and shipping industries are expected to remain sluggish.

Table 1: Growth forecast by industry

Good	Normal	Slowdown	Sluggish
Machinery Semiconductor	Displays Mobile phones Automotives Steel Petrochemicals	Construction	Shipbuilding Shipping

(Source: Korea Development Bank, 2017)

It is the general trend of global economic recovery that investment leads growth. However, in Korea, the degree of growth dependence on investment is much higher than in major countries. Facility investment in the first half of 2017 grew 15.9%, the highest level since 2010. As the global economic recovery shows signs of recovery and the uncertainty of Korean politics is resolved at the beginning of 2017, it seems that the investment that was put off is being resumed. The global semiconductor facility investment expanded by 20% due to the semiconductor industry boom, and Korean semiconductor companies invested USD 40 billion in 2017.

In 2018, the semiconductor industry is expected to make large-scale investments, and the ICT-led investment should continue to grow. In the electronics industry, such as smartphones and home appliances, where domestic investment has been sluggish, investment plans of around CHF 8.3 billion have been announced over three years from 2018. Except for the ICT sector, the manufacturing sector is unlikely to expand investment.

In the aftermath of the structural adjustment, it is unreasonable for the shipbuilding industry to make large-scale new investments, and the steel industry is unlikely to make a full-scale investment as international prices are unlikely to rise further. The automobile industry is also sluggish, and domestic investment is expected to be slow due to an increase in overseas production. It is expected that there will be an increasing tendency to move the production base overseas due to strengthened US pressure. Facility investment growth is expected to slow to 4% in 2018 from double-digit growth of 14.7% in 2017.

3.1 Semiconductor Industry

Semiconductor exports rose 56.5% in the first nine months of 2017. This is due to a surge in global demand for memory and a rise in unit prices due to short supply.

Excess demand for memory semiconductors is expected to continue for the time being in 2018, and the growth will continue as Korean companies expand their market dominance. Exports and domestic demand will increase by 5.0% and 2.2%, respectively, and production should increase by 2.0%, as non-memory related demand will be expanded due to the expansion of new growth industries such as autonomous vehicles and Internet of Things.

3.2 Display Industry

In 2017, domestic display production capacity slightly decreased for LCD, and OLED capacity increased for new investment.

Despite the high growth of the OLED market (+ 39% YoY) in 2018, LCD panel prices are expected to decline due to oversupply and the operation of a new LCD factory in China. Accordingly, exports and domestic demand are expected to remain at 0.7% and 0.6%, respectively, and production will remain flat at 0.4%.

3.3 Mobile phone Industry

Despite the replacement demand in developed countries and the expansion of supply in emerging countries, global competition intensified in 2017, and exports remained sluggish due to increased production overseas. In addition, domestic production and exports have been declining as a result of steadily increasing overseas production.

Exports and production are expected to increase by 5.5% and 3.4%, respectively, due to the launch of next-generation strategic smartphones in 2018, rising average selling prices in line with the trend toward smartphones, and base effect.

3.4 Machinery Industry

In 2017, exports increased due to the increase in demand for overseas facility investment with the global economic recovery. Demand for semiconductor manufacturing machines and flat panel display manufacturing machines has increased, as the semiconductor and display industries are booming in Korea.

Despite constraints, such as slowing domestic facility investment, the outlook for 2018 is expected to continue to recover, driven by the recovery of the global economy and the expansion of overseas demand. Domestic demand is anticipated to increase by 2.5% as capacity expansion continues in downstream industries such as semiconductors. Exports and production are expected to increase by 1.8% and 1.6%, respectively, due to increased demand for robots and automation equipment related to the 4th Industrial Revolution and strong global demand for semiconductors.

3.5 Automotive Industry

In 2017, the automobile industry was in a recovery phase due to the base effect stemming from the strike in 2016 and strong exports from overseas demand expansion.

In 2018, exports and domestic demand will remain sluggish, while production, exports and domestic demand are expected to decline by 0.9%, 0.5%, and 1.5%, respectively, while overseas production of domestic companies will expand.

[Korean Major Companies Investment]

SAMSUNG ELECTRONICS

Major investment plans planned by major Korean companies including Samsung are summarized briefly.

[Semiconductor]

Samsung Electronics spent USD 14 billion on 3D NAND flash in 2017, and USD 7 billion and USD 5 billion on DRAM and foundry, respectively.

Over the next three years, the company plans to invest a total of USD 7 billion in the Xian plant in China to expand its 3D NAND flash line. It is estimated that this investment includes plant construction costs and primary equipment investment. If the design capacity of the 2nd plant is about 100 ~ 110K, which is similar to that of the first plant, the investment of the second equipment will be added, and the total investment of the 2nd plant will be over USD 10 billion. When construction is completed by the end of 2018, equipment investment is expected to start in earnest from early 2019.

[Display]

Samsung has begun construction of its sixth-generation flexible OLED production line 'A5' (tentative name), which will be able to produce up to 270,000 sheets per month from 180,000 units at its new factory site in Cheonan and Asan in Chungcheongnam-do. It is estimated that only about USD 16 billion will be invested in equipment investments, excluding factory construction costs. The total investment period is three years, and equipment is expected to be ordered from 2017 to the first half of 2021.

[Mobile phones]

The vice chairman of Samsung said that in the long run, Samsung would change its business structure to derive more profit without making a lot of capital investment like Apple does. In other words, Samsung is going the 'Apple Way'. In order to derive profits, it means that Samsung does not operate a direct production plant but rather focuses on outsourcing by maintaining a thorough outsourcing system.

LG DISPLAY

LG Display plans to increase OLED production from 1.8mn units in 2017 to 2.5mn units in 2018. By 2020, LG Display plans to invest USD 20 billion in OLED projects, including USD 15 billion in Korea and 5 billion in China. First, it has attracted USD 1 billion from Google to invest in OLED for smartphones, and Apple is under intense negotiations to receive USD 3 billion in prepayments. The TV OLED plant led to large-scale investment in China, subject to construction in Guangzhou, China.

The new mobile OLED panel division plans to invest USD 5 billion more on the E5 and E6 lines and invest an additional USD 5 billion on the E6 line.

HYUNDAI MOTORS

The Hyundai-Kia Automotive Group is planning to expand its production capacity and build a global business center (GBC) by constructing and expanding its facilities over the next four years. The company will invest USD 49 billion in facility investments and USD 31 billion in research and development. In particular, three-quarters of the total investment are concentrated in Korea. The amount invested in the country is USD 61 billion, which is 76% of the total investment plan. By 2018, the company will invest USD 11 billion to develop a variety of eco-friendly cars, including plug-in hybrid, hybrid and electric car models, and hydrogen fuel cell vehicle models. The company plans to invest USD 2 billion in smart cars to improve autonomous driving and vehicle IT technology.

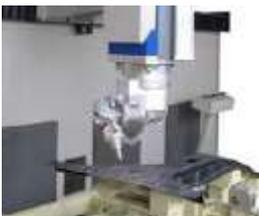
4. Machine Tool Market

The Korean machine tool industry is expected to grow at a CAGR of 9.46% until 2019, and its size is expected to reach about CHF 16 billion. It results from Korea's automobile, electronics, and machinery industries are growing steadily. The total imports of machine tools from Switzerland amount to about USD 82 million, about 7% of total imports, but it is the third largest after Japan and Germany. Machine tools are evolving toward multitasking, hybridization, and intelligence, but the demand for their products is changing to small-lot production.

4.1. MARKET DEFINITION

Precision micromechanical systems, that is, machine tools, are machines that process workpieces in various shapes and sizes using various cutting or non-cutting methods. In other words, they are called 'machines for making machines' (Mother Machine), which is the core equipment of the capital goods industry.

Table 2: Classification of machine tool industry

Classification	Scope
High-speed Multitasking machining 	High-speed (100,000 rpm), large, complex cutting and high-efficiency forming systems. Reduced lead time, shorter machining time, and improved cutting ability are realized by changing the machining method while utilizing existing tools. This includes multitask CNC machining centers that combine a CNC machining center, which is a process intensive CNC machining center, and a CNC turning center.
Precision machining 	Ultra-precision mold processing equipment, ultra-precision milling equipment, fine processing equipment, ultra-precision inspection equipment. Ultra-precision measurement and inspection technology.
Hybrid processing 	Laser-assisted machining, ultrasonic hybrid machining, and high energy beam fusion machining systems. Technology that maximizes processing efficiency by fusing laser, ultrasonic, and energy beams to the existing processing system.

Intelligent machining



A simulation-based digital control platform, and a flexible production system (FMS). And smart factory technology based on process and system and data.

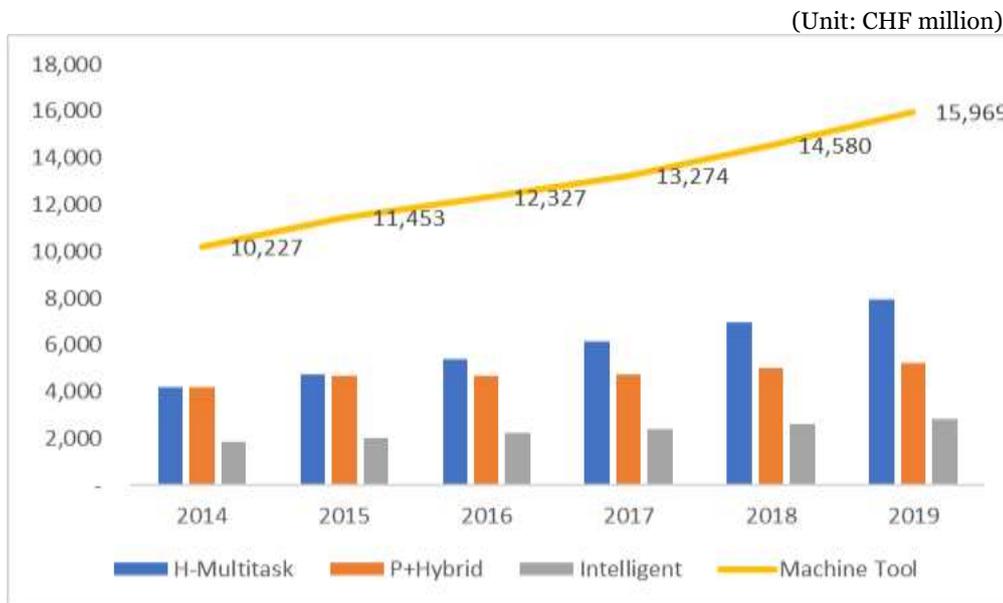
(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

Nano / micromechanical systems, which include traditional precision production machines such as lathes, CNC machining centers, drilling machines, milling machines, boring machines, grinding machines, gear processing machines and presses, processing of ultra-small workpieces, related parts and the like are included in the above categories.

4.2. MARKET SIZE AND GROWTH

According to a report issued by the Ministry of SMEs and Startups in 2016, the machine tool industry market was expected to grow at a CAGR of 9.46% from CHF 10,227 million in 2014, to reach CHF 15,969 million in 2019 as shown in the figure. The size of the precision machining and hybrid processing markets are summed together as the market of the Precision+Hybrid processing in the figure and table below.

Figure 1: Domestic market size and forecast of machine tool industry



(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

Table 3: Domestic market size and forecast of machine tool industry

(Unit: CHF million)							
Classification	2014	2015	2016	2017	2018	2019	CAGR(%)
High-speed Multitasking machining	4,174	4,745	5,394	6,131	6,969	7,922	13.67

Precision+ Hybrid processing	4,216	4,687	4,710	4,735	5,004	5,223	4.38
Intelligent machining	1,837	2,021	2,223	2,408	2,607	2,824	8.30
Total	10,227	11,453	12,327	13,274	14,580	15,969	9.46

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

4.3. MACHINE TOOL BUSINESS ENVIRONMENT

4.3.1. Machine Tool Market Policy Update

As tariff barriers become lower due to the expansion of free trade agreements (FTA), there is a tendency to actively utilize non-tariff barriers that are not clearly visible. The number of technical barriers to trade (TBT) notifications in the machinery sector has been steadily increasing from 69 cases in 2013 to 108 cases in 2015.

The Korean government is expanding the certification and mutual recognition agreements (MRA) for major international standards. The government is particularly expanding support of both the cost of acquisition of overseas standard certification and the consulting which is a big burden for SMEs.

The government is continuing R&D support on an ongoing basis. In 2015, the Ministry of Trade, Industry and Energy supported roughly CHF 83 million for the manufacturing industry and CHF 230 million for the industry of material and parts with R&D budget. This is because the dependence of core equipment on advanced countries is high, and there is a growing dilemma in which equipment imports surge in proportion to the growth of the product industry.

The Korean government plans to implement the policy of manufacturing innovation 3.0 and build 10,000 smart factories by 2020. It is being performed for 13 major industries such as parts assembly, PCB, casting, mold, press, and injection molding.

4.3.2. Machine Tool Market Industry Update

Despite the decline in imports and exports of the machinery industry, the machine tool sector showed an increase in production, shipments and inventories. (As of July 2016)

- Production in the machinery industry shows a decline in all areas except *precision machinery*.
- Metal products (-8.8%), transportation machinery (-5.9%), electrical machinery (-4.2%) and general machinery (-4.0%) declined while the precision machinery sector increased by 10.2%.
- Demand for mid-end models such as CNC machining centers, which are the dominant models of domestic manufacturers, is increasing due to the rapid expansion of emerging markets such as China.

Korea's machine tool industry is concentrated in large companies.

- In the domestic machine tool market, three large companies such as *Doosan Infracore, Hyundai Wia, and Hwacheon Machinery* occupy more than 90% of the total market. In particular, Doosan Infracore and Hyundai Wia are the leading companies in the market.
- However, the micro-machine system sector is being dominated by SMEs. Because it is dependent on large companies for exclusive supply requirements, there is a limit to the growth potential of micro-machine system companies and their own technology development.

M&As in the domestic machine tool sector are accelerating.

- Manufacturers of small and medium-sized machine tools are seeking to exploit new opportunities through M&As. This is because not only the economic recession continuing over a long period of time, but it is lagging behind competition from large corporations.

4.3.3. Machine Tool Market Update

Leading overseas companies are expanding their dominance in the global market.

- DMG Mori-Seiki (<https://www.dmgmori.co.jp/en/top2/>) has grown into the world's No. 1 machine tool company through alliances with Mori-Seiki (Japan). The global market dominance of these global companies is expanding through overseas production bases and system packaging.

In the field of precision machining systems in Korea, large companies are developing CNC turning centers, process-intensive multitasking machining equipment, and equipment for processing new materials.

- Doosan Infracore (<http://www.doosaninfracore.com/en/>) completed a large-scale machine tool production plant with a production capacity of 1,000 units per year in 2014, but recently sold its machine tool business to MBK Partners in 2016.

The demand for high-end class packaging equipment is expanding due to the demand for a flexible production system that can be tailored to small quantity production of multiple types.

The demand for high-efficiency, environmental-friendly, and energy monitoring-based processing equipment is increasing due to environmental and energy regulations.

The domestic micromechanical systems sector mainly sells systems that produce electronic devices required in the Chinese market.

4.3.4. Machine Tool Industry Technology Update

Micro-sized shape processing technology is being actively developed in the automobile and electronics industries.

- Despite emotional and multidimensional design needs, the related exterior design and design techniques are inadequate.

Large companies are aggressively investing in the transition to a quality management system based on ICT, but SMEs are experiencing difficulties in making investments.

Domestic companies are in need of basic technologies in the field of new process and hybrid machining systems, while conducting basic research on fusing technology with other processes for high efficiency.

4.4. IMPORTS FROM SWITZERLAND

According to statistics on import trends released by the Korea Machine Tool Manufacturers' Association (<http://www.komma.org/komma/eng/Introduction.do>), imports of machine tools have been decreasing since 2014 as shown in the following figure and the amount of imports is USD 1.2 billion as of 2016.

This shows that Korean economic growth rate and machine tool imports are closely related. Korea is a representative country where the economy grows when investment in capital goods becomes active. The table below shows this correlation to the previous bar graph.

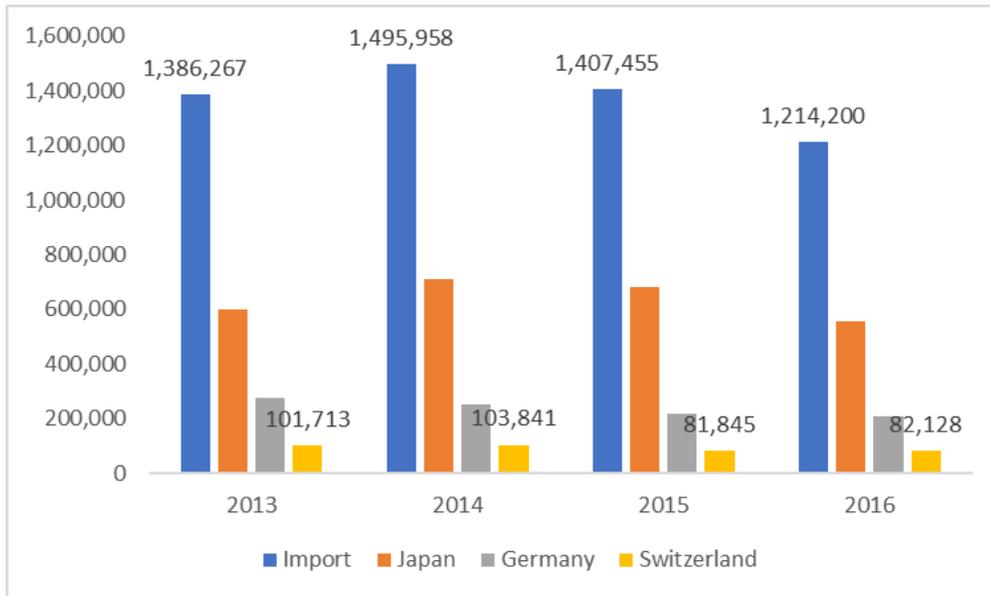
Table 4: Trend of Korea's economic growth rate

Year	2013	2014	2015	2016	2017(E)	2018(P)
Economic Growth (%)	2.9	3.3	2.8	2.8	3.0	2.9

(Source: Korea Economic Outlook for 2018, Korea Development Bank)

Figure 2: Imports of machine tools

(Unit: USD 1,000)



(Source: Import statistics of machine tools, Korea Machine Tool Manufacturer’s Association)

The import volume from Japan is about USD 555 million, which accounts for roughly 45% of the imports and is the top among machine tool importing countries. Germany is the next, amounting to USD 206 million, and the third is from Switzerland with about USD 82 million, approximately 7% of total imports.

5. High-speed Multitasking Machining Systems

This market occupies the largest portion of the entire machine tool market. As of 2019, it accounts for about 50% and it is growing faster (CAGR of 13.67%) than the growth rate of the entire machine tools market (9.46%). In relation to high-end products such as precision machining equipment and grinding machines, Japan, Germany and Switzerland are competing in the Korean market, where sales of Korean domestic products only account for 31%.

5.1. MARKET DEFINITION

Machine tool technology is a trend involving high-speed, multi-dimensional, multitasking, and precision. Today, manufacturing industries are proceeding with a lack of skilled workers, production of small quantity of varieties, flexible production, short lead times, cost reduction, weight reduction, and an increase of complicated shaped parts due to the complexity of functions. Therefore, multitasking machines are being developed as manufacturing equipment capable of reflecting such an environment.

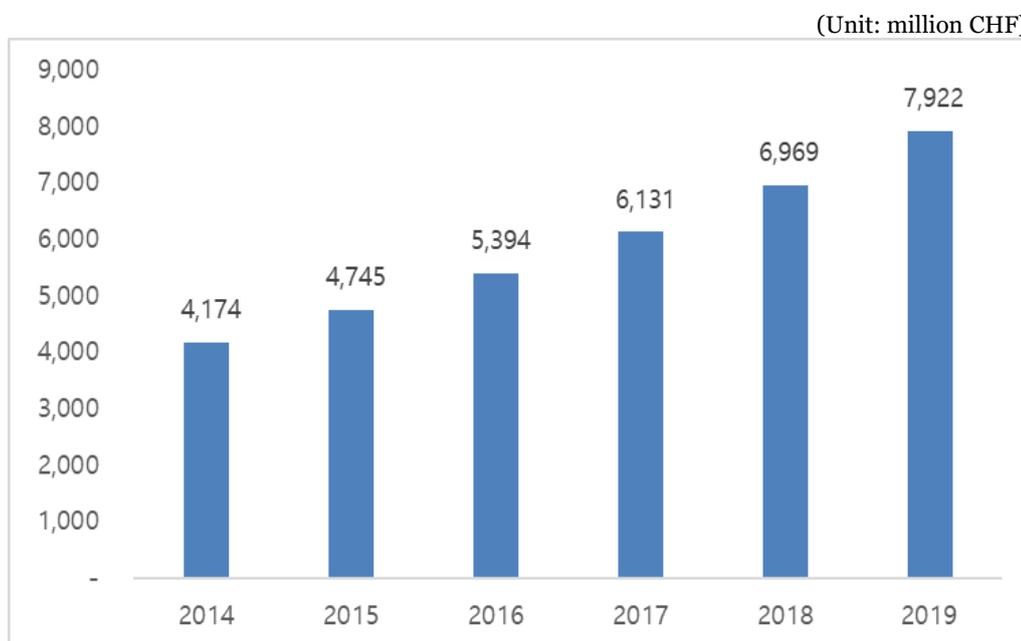
High-speed machines produce products in a mold at a higher spindle speed and a higher feed rate than the conventional machining method. Precision multitasking machines are machines that can perform multiple processes and tasks with one machine to process complex workpieces.

A high-speed multitasking machining system is a system that adopts the high speed of a main spindle and feed system, tool interface technology, CNC control technology and new mechanism (Parallel Mechanism). In other words, it means a system where a CNC machining center for milling, a turning-center for turning, and a high-speed machining system are combined.

5.2. MARKET SIZE AND GROWTH

The domestic market for high-speed multitasking machining systems is expected to reach about CHF 7,922 million in 2019, with a CAGR of 13.67%. This market occupies the largest portion of the entire machine tool market. As of 2019, it accounts for about 50%. And it is growing faster than the growth rate of the entire machine tools market (9.46%).

Figure 3: Domestic market size and forecast of high-speed multitasking machining systems



(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

5.3. BUSINESS ENVIRONMENT

5.3.1. Policy Update

The government is expanding the activity of the ISO committee and funding the part sharing project. Also, they have supported the development of technology for component modularization to build the infrastructure of B2B businesses.

5.3.2. High-speed Multitasking Maching Systems Market Update

The downstream industries of machine tools include the automobile, electrical and electronic equipment, communications equipment, shipbuilding and mold industries, and upstream industries include steel, parts, materials, and tools.

Table 5: Up and downstream industries of high-speed precision multitasking machining

Upstream industries	High-speed Multitasking Machining System	Downstream industries
Steel Parts Materials Tools		Automobiles Electrical and electronics Shipbuilding Precision machines Semiconductors Molds

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

The domestic machine tool industry has secured the global market with CNC lathe and CNC machining center, and has its proprietary design technology for hardware: however, even though Korea is an advanced country with respect to internet connectivity, machine tool technology using ICT does not reach the level of an advanced country, as of yet.

In the domestic machine tool sector, the size of the company is generally small, and the R&D investment and marketing ability is weaker than that of developed countries. Most local Korean companies depend on domestic demand, their export destinations are concentrated, and their dependence on parts imports is intensifying. Since the core parts are imported from the main competing countries, their competitiveness in the international market is weak. The construction of the technology infrastructure is insufficient, and there is also a lack of professional manpower.

In order to secure the quality competitiveness of products, domestic machine tool manufacturers prefer to develop products using key parts supplied from suppliers of advanced countries such as Japan and Germany, rather than technical cooperation with small and medium-sized domestic companies.

- Technical competitiveness of core parts such as CNC machines, servo motors, spindle, bearing, and transfer systems is insufficient.
- In particular, high value-added products such as high-efficiency, high-flexible equipment required in demand industries such as automobiles, and ultra-precision, micro equipment in semiconductor and electronics fields are mostly dependent on imports.

The domestic cutting tool market is dominated by large companies, with the exception of machining systems, which are difficult to process like titanium.

- Domestic tool manufacturers are very dependent on imports of raw materials for tools and are very small. These companies mainly focus on carbide end mills and coated tools, and there is a technology gap with advanced overseas countries.

5.3.3. High-speed Multitasking Machining Systems Market Update

In recent years, the machine tool market has been dominated by companies that maintain price competitiveness of standard equipment and low-cost equipment due to the long-term decline in demand for high-value equipment. In the future, it is expected that the equipment to perform the combined process to improve the productivity through shortening the non-cutting time and the ability to develop high-speed and high-precision equipment will dominate the market. Securing product reliability and cost competitiveness will be key factors driving the market as well. Sales network, after-sales service, and quality based on specialized technology are the main competitive factors among companies.

Some high-end products such as precision machining equipment and grinding machines are competing with imported products of Japan, Germany and Switzerland, and Korean products account for 31% of domestic machine tool demand.

High-end equipment, operational solutions for flexible production, and core components such as controllers, servo motors and drives are the key elements of smart factories, and they are mostly imported from Germany, Japan and the United States.

- In the case of PLC products, specialized companies such as LS Industrial Systems have a domestic market share of about 33%; however, the market share of high-end products is not easily increased due to aggressive market strategy of foreign companies.

In recent years, factory automation related to the production of the entire plant has been advanced beyond the NC of the machine itself. There is a processing cell composed of a unit machine tool, which is connected to a robot having an automated function, an unmanned vehicle, and an automated warehouse. Furthermore, it is being developed in the form of FA (Factory Automation) or FMS (Flexible Manufacturing System), which is a step of automating the entire plant by connecting with an advanced computer.

- Large machine tool makers such as Mazak(<https://www.mazak.com/>), Mori-Seiki in Japan and DMG in Germany are developing various types of multitask machines using ICT-based high-efficiency multitask processing system and introducing their products to the market.

In order to cope with product changes and lead time reduction, technology focus is changing from high speed and complex process in the direction of doubling the flexibility of platform itself.

- In the automotive sector, which is the largest customer, the environmentally friendly and highly efficient processing market for materials that are difficult to process is rapidly expanding.
- Competition for development of large-scale multitasking machining systems is fierce due to the growth of industries such as aviation, shipbuilding, and wind power.
- Mazak, DMG, Mori-Seiki and other advanced companies have developed fusion equipment such as One-Chucking, Multi-Machining and Done-In-One on a single platform. Non-cutting processes using ultrasonic and laser are added to cutting and grinding processes to improve machining quality and productivity.

5.3.4. High-speed Multitasking Maching Systems Technology Update

Research on the technology for constructing a system to monitor the state of the machine tools and the machining process using sensor fusion and networking technology is actively being conducted.

Advanced companies in countries such as Japan and Germany have commercialized various intelligence elements and installed them in high-end equipment. (Monitoring the spindle state by itself, preventing collision, autocorrection of unbalanced jigs, active vibration control for transport systems, correction control of thermal displacement, etc.)

The technology gap with advanced countries is widening in high value-added core technologies such as high-speed, high-precision, multi-function, complex, flexible, intelligent and compact.

- Compared with advanced countries, diversification of main models such as CNC machining centers, CNC lathes, CNC turning centers, and electric discharge machines is still lacking in various commercialization.
- In particular, the development and production of ultra-high speed, ultra-precision, and multi-path combined processing machines are being carried out, but the accuracy, stiffness, and reliability are significantly different from those of advanced countries.

Technologies that Korean companies are interested in:

12-axis drilling machines, high-output magnetic drilling machines using BLDC motor, 8-axis CNC automatic lathes for precise part machining, CNC machines for automatic cutting and boring, hobbing machines for high speed and precision machining, CNC synchronous 5-axis tools for remote support grinding machine, precision control type 2-head hybrid broaching machines, large vertical lathes for tower ring processing of wind power generators, high-speed cutting hobbing machine technology for high-hardness product processing, spindle speed improvement technology of CNC Drill Machine, boring tools for backface holes, continuously variable transmission for speed control of spindle in table drill, high speed boring spindle assembly units, ATC air spindles for machine tools with super high-speed/super precision air bearing, multi stamping unit for mounting material for milling.

5.4. MAJOR PLAYERS

The world-leading manufacturer of machine tools, Mazak's 'Integrex-e series e-Tower' not only collects a variety of information from machine tools, but also maximizes unmanned machining time with production line monitoring equipment. It provides the worker with remotely providing the machining process, training, maintenance, and schedule information.

'CELOS' of DMG-MORI enables production and quality control through linkage between machine and upper system (ERP, MES, etc.). The new HMI (Human Machine Interface) is aiming for a digital manufacturing environment to simplify and speed up the entire process from ideation to final product processing.

Doosan Infracore (<http://www.doosaninfracore.com/en/>) is the fifth largest machine tool maker in the world, focusing on CNC turning centers, CNC machining centers, NC boring machines, Swiss-type machining, and automation systems. In 2014, Doosan Infracore completed a large-scale machine tool manufacturing plant with a production capacity of 1,000 units per year.

Sales of CNC turning centers, CNC machining centers and large-scale processing machines account for more than 50% of Hyundai Wia's total sales. Recently, Hyundai Wia (<http://en.hyundai-wia.com/main/main.asp>) has expanded its production capacity by adding two factories in China and introduced a product that can monitor the condition of equipment by adding IoT function to NC controller.

Hwacheon Machinery (http://www.hwacheon.com/en/main_intro.do) has a similar share of exports and domestic sales in total sales. They have developed intelligent machine tools that analyze machining models by themselves and generate process machining data, and are developing middle and large vertical CNC machining centers.

Table 6: Major players in the market of high-speed multitasking machining system

Category	Big companies	SMEs
High-speed machining	DOOSAN INFRACORE, HYUNDAI WIA, HWACHEON, SIMPAC, LS MTRON, SONGBOW	HNK MACHINE TOOL, SKEM, CESCO, DAEYOUNG MACHINERY, KIHEUNG, DONGSHIN PRESS, WOJIN PLAIMM
Multitask machining	DOOSAN INFRACORE, HYUNDAI WIA, HWACHEON, SIMPAC, LS MTRON	HNK MACHINE TOOL, SKEM, CESCO, DAEYOUNG MACHINERY, KIHEUNG, DONGSHIN PRESS, WOJIN PLAIMM
Machining for hard material	DOOSAN INFRACORE, HYUNDAI WIA, HWACHEON, SIMPAC, LS MTRON	NANOTECH, WINANTECH

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

6. 3D Printing Industry

The size of the 3D printing system in Korea is estimated to be CHF 35 million as of 2013, with an annual average growth rate of 40%, which is expected to be CHF 263.3 million in 2020. However, Korean companies occupy only 10% of the market and depend on overseas technology.

6.1. MARKET DEFINITION

3D Printing is a process of manufacturing 3D objects by stacking materials using digital design data. This concept is contrasted with cutting processing, which is performed by cutting or carving materials. The official term is AM (Additive Manufacturing) or RP (Rapid Prototyping). It can be classified into various technologies depending on the lamination method and the material to be used. Examples of the lamination method include extrusion, inkjet injection, photopolymerization, powder sintering, drawing, and sheet bonding. Examples of usable materials include polymers, metals, paper, wood, and foodstuffs.

With 3D Printing it is easy to produce small quantity of various kinds and customized production. It has many advantages such as cost reduction of prototypes, time-saving and simplification of manufacturing processes. It is expected to lower the fixed cost of mold investment, enable small-scale production to see the reaction in the market, and reduce management risks by reducing inventories.

As shown in the table below, 3D Printing related technology is divided into sub-technologies such as modeling, printing, post-processing, and materials.

Table 7: Classification of 3D printing industry technology

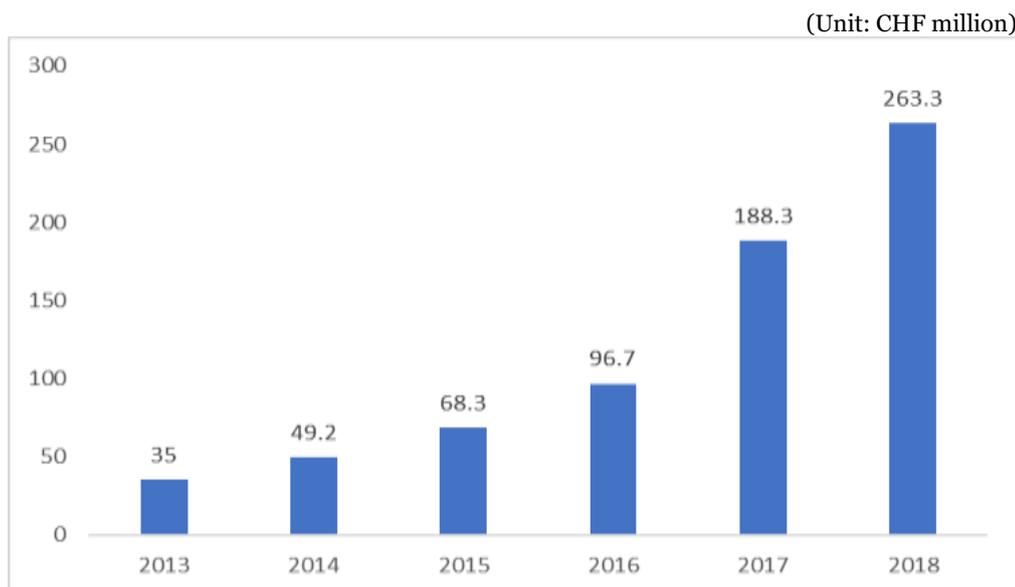
Category	Sub technologies
Modeling	3D design conversion, 3D scanning, 3D design software
Printing	Fine nozzles, micro-injection technology, energy source (heat, laser, electron beam) output control technology, precision position control, high-speed control
Post-process	Coloring, polishing, surface material deposition
Material	Proper Melting and Curing Control

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

6.2. MARKET SIZE AND GROWTH

The size of the 3D printing industry in Korea is estimated to be CHF 35 million as of 2013, with an average annual growth rate of 40%, which is expected to be CHF 263.3 million in 2018. Although it has grown rapidly since 2013, Korean companies account for only 10% of the market and depend on overseas technology. Small and venture companies have developed products and entered the initial stage of commercialization, but they lack the capacity to preoccupy the market.

Figure 4: Domestic market size and forecast of 3D printing systems



(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

6.3. BUSINESS ENVIRONMENT

6.3.1. 3D Printing Industry Policy Update

The government proposed the development strategy of the 3D Printing industry in 2014 under the vision of 'becoming a leading global 3D Printing country in 2020'. And they are carrying out 11 tasks in the following four fields. Specifically, it is pursuing strategies such as ① creating a demand-linked growth base, ② supporting business activation, ③ securing technological competitiveness, and ④ improving 3D Printing related regulations. It is promoting the technology development of equipment through linkage with the demanding industry, for example:

- The government will invest CHF 17 million for 5 years and promote linkage with Daegu High-tech Medical Complex and 13 companies for 'ICT-based medical 3D Printing application SW platform and service technology development' project.
- The government will establish the 'Center for Manufacturing Innovation Support' in 6 places in the entire country to support 3D Printing in major manufacturing industries such as automobile, electronics, and aviation.
- The government will set up a center for comprehensive technical support in the Seoul metropolitan area and establish a regional base center linked to specialized industries by five regions (Chungcheong, Gangwon, Daegu, Southeast, and Southwest).

6.3.2. 3D Printing Industry Update

In the 3D Printing equipment market, which is the core of lamination manufacturing, most of the industrial uses are made by manufacturers in the US, Japan, and Germany. The material is also mostly imported from foreign countries due to the industrial structure that sells equipment and materials. Korean companies are not participating in the global market due to the lack of fundamental technology, material, and software development related to 3D Printing equipment.

Table 8: Up and downstream industries of 3D printing system

Upstream industries	3D Printing	Downstream industries
Printers Scanners Parts Materials Tools		Automotive Aerospace Shipbuilding Medical Construction Education

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

In the industries where the 3D additive manufacturing system is being used heavily, the consumer goods industry is the highest at 21.8%, followed by automobile 18.0%, medical and dental 16.4% and industrial machinery 13.4%.

The 3D printing system industry is directly influenced by the automobile industry.

6.3.3. 3D Printing Industry Market Update

A small number of leading manufacturers of laminate manufacturing equipment occupy more than 70% of the market, and equipment suppliers are leading the supply of materials through direct material development.

- Equipment:

It is divided into domestic makers and foreign makers. The number of domestic makers is estimated to be about 48. About 25 of these companies are constantly selling products, while the rest are developing technologies or watching the market environment.

- Software:

It is divided into domestic software developers such as Intelli Korea, Loibiz and 3D TADA, and some foreign software vendors.

- Material

There are three major companies that sell materials in Korea. Companies that develop FFF filaments such as Daelim Chemical and 3D Korea, developing raw materials such as SK Chemicals and LG Chem, and selling foreign equipment such as Stratasys Korea and 3D Systems Korea.

- Application services:

The companies utilizing the related technology are composed of laminating manufacturing agency, figure production, and education.

Machine tool makers such as Smack, DMG Mori Korea and Sodick Korea exhibited 3D lamination manufacturing equipment which combines cutting function with existing lamination processing method at SIMTOS Seoul International Machine Tool Show 2016 in Korea.

6.3.4. 3D Printing Industry Technology Update

At present, the level of additive manufacturing technology is in the stage of developing various technologies to overcome the disadvantages such as reduction of production time, improvement of precision, and development of metal material. Leading companies in the US and other countries around the world are propelling 3D core manufacturing technology (SLS, SLA, etc.), and Korean companies have weaker equipment manufacturing technology. Some domestic companies have technologies such as Digital Light Processing (DLP) and Direct Metal Tooling (DMT), but most are using global technologies such as SLS and SLA. The development of related materials and software is insufficient and most of them depend on foreign companies.

6.4. MAJOR PLAYERS

More than 190 companies are involved in additive manufacturing in Korea, and domestic 3D additive manufacturing equipment suppliers are small and medium-sized companies that mainly produce low-priced industrial and personal equipment. As a manufacturer of equipment, a small number of companies are engaged in the market, such as CARIMA, INSSTEK, and ROKIT. OPENCREATOR manufactures personal 3D printers using the FDM method, and INUS Technology possesses 3D design software technology.

CARIMA (<http://www.carima.com/>) manufactures industrial printers using DLP method, which is not complicated in mechanical structure. It developed 'Master' by automatically stacking liquid plastics and models for general, medical, and jewelry design. The company develops and produces five types of photocurable materials such as acrylic and epoxy. The core DLP module is purchased externally (Texas Instruments). The export performance is being increased, but the sales volume in 2016 was about CHF 1.2 million.

INSSTEK (<http://www.insstek.com/>) is a manufacturer of industrial 3D additive manufacturing, which is known to succeed in developing most of its own technologies, and developing metal powders and printers based on Laser-aided DMT technology. The company is also known to have developed the world's second-leading Directed Energy Deposition technology following a US company. LG Electronics and Hyundai Motor are customers of the company, and the equipment is being supplied to various fields such as electronics, automobile, and medical care.

ROKIT (<http://www.3disonprinter.com/>) developed 'Edison', which can be operated as a desktop based on open source technology, and recently released a model that can use more than two nozzles.

INUS Technology has been awarded for 3D Systems (US) for about USD 35 million in 2012, thanks to its excellent 3D software technology. The company has changed its name to 3D Systems Korea (<https://www.3dsystems.com/>).

Table 9: Major players in the market of 3D printing system

Category	Foreign companies	Korean companies
Industrial	Stratasys (USA) 3D Systems (USA)	CARIMA INSSTEK TPC MECHATRONICS
Personal	Maker Bot (USA) Cubify (USA)	ROKIT OPENCREATORS
Printing services	-	3D SYSTEMS KOREA TRUEVINE

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

7. Robotics Industry

The Korean robotics market is expected to grow to as much as CHF 4 billion by 2019. The application of industrial robots in Korea is ranked second in the world by utilizing about 40,000 robots in 2015. This is the second largest such usage in the world, but it is the world's largest robot density (the number of industrial robots per 10,000 workers), which relates to robot dependence in the industry. In the future, the number of smart factories is expected to increase further due to developments in the Internet of Things and cloud computing, therefore the industrial robot market in Korea is expected to grow further. In particular, demand for collaborative robots that collaborate with humans in the industrial field is expected to increase.

7.1. MARKET DEFINITION

The robotics industry is divided into *manufacturing robots*, *professional service robots*, *personal service robots*, *robot parts*, *robot systems*, *robot embedded*, and *robot services*.

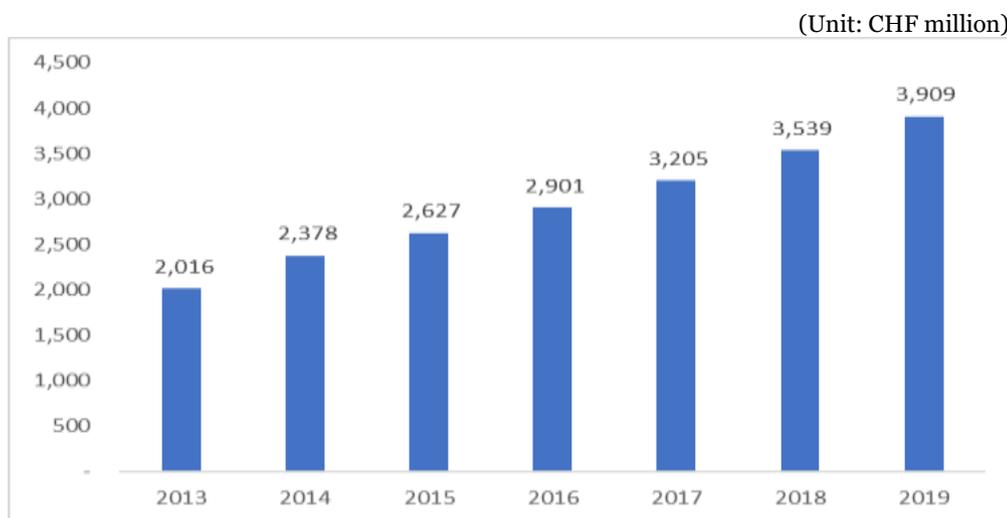
- *Manufacturing robots* perform in-process tasks from product manufacturing to shipment at each industrial manufacturing site.
- *Professional service robots* are non-manufacturing robots that provide services for an unspecified number of people, carrying out specialized work, and providing useful services for people's well-being, specific facilities or special purposes.
- *Personal service robots* are closely related to services such as personal health, education, housekeeping, safety, and information provision in the human life category.
- *Robot parts* are all intermediate products used to produce robots.
- *Robot system* is an aggregate that realizes functions required by combination of robot, machine, and device.
- *Robot embedded* is not a shape of robot, but it is a product with robot technology.
- *Robot service* is to provide convenience to people by utilizing robot.

7.2. MARKET SIZE AND GROWTH

According to a survey on the status of robotics in Korea, the domestic robotics market in 2014 produced about 23,000 robots, making it the fourth most developed robot market in the world. Industrial robots account for 85% of domestic production, and service robots and robot parts account for 15%. The size of the robotics market is estimated to be CHF 2.016 billion in 2013 and CHF 3.909 billion in 2019, as shown in the following figure.

According to the International Robot Federation, industrial robots in Korea accounted for 38,300 units in 2015, as production automation for automobiles and IT-related manufacturing sectors is rapidly progressing. Korea is the world's largest robot density (the number of industrial robots per 10,000 workers), and industrial robots are mainly used for handling and logistics. In particular, as smart factories are expected to increase due to the development of the Internet of Things and cloud computing, the market growth of industrial robots is expected to expand further.

Figure 5: Domestic market size and forecast of robot industry



(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

7.3. BUSINESS ENVIRONMENT

Robotics business environment is briefly summarized in four aspects as follows.

7.3.1. Robotics Industry Policy Update

To foster industrial robots, a policy has been established in the 1990s and the government began to pay attention to intelligent robots in the 2000s. From 2008, the government has implemented a full-scale policy by strengthening the legal and institutional basis related to intelligent robots.

Based on the second basic plan for intelligent robots in 2014, the government revised and promulgated the Enforcement Decree of the Act on the Development and Promotion of Intelligent Robots in 2016. The government will invest about CHF 417 million to expand the robotics industry, and CHF 12.5 million by 2020 to create a research base for robots.

Table 10: Government policies for robotics industry

Year	Policy
1978~1996	Established the foundation for developing robots for manufacturing
1997~2001	Switched to a policy of developing intelligent robots
2002~2007	Intelligent robots were selected as the next generation growth engine for the 10 th generation

2008~2015	Strengthened the legal and institutional basis for intelligent robots Korea Robot Promotion Foundation was established The Ministry of Trade, Industry and Energy has newly established a department dedicated to robots
2017	The transfer robot was applied to the hospital Rehabilitation robots were introduced At the PyeongChang Olympic Games, a robot that guides, promotes, transports and guards is in operation
2018~2020	Expansion of robot deployment - Apply artificial intelligence based social robot to the post office - Apply surgical robots to public hospitals - Apply the transport robot for warehouses as a pilot - Demonstrate social robots for exhibitions and museums - Demonstrate safety robots for monitoring at power generation facilities

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

7.3.2. Robotics Industry Update

In the future, the electronic products market will be transformed from electronic products incorporating robotic technology to electronic products based on robot technology, and robotic technology is expected to be widely used in various industries. Logistics robots are expected to be developed to include and utilize autonomous navigation functions that can gradually perform various tasks from the function of simply moving at factories or warehouses. With the development and application of ICT technologies using the Internet and Big Data, the mobile platform will be able to easily receive and utilize various environmental information from the external environment, and lead the development of the robotics industry.

7.3.3. Robotics Market Update

There is little investment in service robots that do not guarantee short-term profitability compared with industrial robots. Currently, the government's policy support is leading the growth of the industry.

As a result of the technical demand survey, it is known that the demand for the following robots is high:

Low-cost smart cooperative industrial robots, unmanned security control robots, industrial safety fall-off airbags, automatic assembly equipment for parts, welders, robot guidance, 360VR cameras, underwater positioning systems for marine information collection, micro drill bits, laser marking systems, Industrial robots, precision reducers for robots.

7.3.4. Robotics Industry Technology Update

According to the recent 3-year average R&D increase/decrease trend, software technology (11 cases) related to robots and automation machines is increased by 75%, followed by machine automation technology by 18%, and other robotic and automation machine related technologies increased by 17%.

The analysis of the main R&D tasks submitted to the government revealed that the technology and products that SMEs are interested in as follows.

Field of Robots that support housekeeping: Cleaning robot products are in high demand for development, and demand for the following technologies is high.

- Indoor autonomous navigation and path control
- Self-location recognition of cleaning robot
- Wheel module for autonomous driving
- Environmental awareness and judgment based on environmental signals
- Learning intelligence
- Household support HRI (Human Robot Interaction) standardization for robots
- Standardization of operational performance test
- Choose action according to the situation

Field of Social Robot Platform and Service: Demand for development of stage robots and unmanned security control robots is high, and demand for the following technologies is high.

- Robot face for emotional expression
- Flexible gestures and posture expression
- Emotional robot platform design and system integration
- User emotion recognition
- Multi-modal dialogue scenario authoring technology
- Multimodal recognition control integration
- Remote monitoring and control
- Communication for user interaction

Field of Strength assisted robots for the elderly and the disabled: Falling airbags for elderly people have a high demand for product development, and demand for the following technologies is high.

- Ergonomic robot design
- Body stability assurance design
- Wearing convenience considering design
- Motion detection sensor system for intention detection
- User's strength measurement
- High-precision, high-efficiency drive system design
- Control algorithm for non-resistance driving

Field of Sports Simulator Robot: Falling airbags used in sports is high demand for product development, and demand for the following technologies is high.

- Multi-Degree Motion Platform
- Servo motion control for motion platform
- Realistic reproduction device for sports simulator
- A device for realizing the content and implementing the feedback effect
- Projections for realistic rendering and immersive environments
- User motion recognition and interpretation
- Precise analysis and virtual coaching for sports motion

Field of Logistics Robot: It is shown that there is a lot of interest in industrial logistics robot product demand and the following technology demand is high.

- Transport/handling technology
- Rapid and efficient platform development
- Machine vision recognition technology
- Sensor recognition technology
- Precision mechanical design technology
- Motor control
- Computer interfacing technology
- Robot control
- Vision measurement
- Remote control

Field of Human-friendly cooperative robots: Robot movement switch automation and industrial robots are in high demand, and the following technology demand is high.

- Increased degree of freedom through multiple joints
- External contact and shock detection
- Motion learning control algorithm
- Cooperative Robot Stability
- Storage technology
- Technique for analyzing and calibrating human motion

Field of Medical Rehabilitation Robot: The demand for robot medical device development for rehabilitation is high, and the following technology demand is high.

- Model design according to wearing phase
- Portable sensors for behavioral patterns detection
- Smart home technology for the disabled

7.4. MAJOR PLAYERS

Hyundai Robotics (<https://www.hyundai-robotics.com:5008/english/>) spun off the robot division from the engine business division in July 2015 and is participating in the overseas plant expansion of Hyundai Kia Motors and its subsidiaries.

NAVER (<http://www.navercorp.com/en/index.nhn>) announced plans to invest about CHF 83 million in unmanned vehicles, smart homes and robots for the next five years starting from September 2015.

Samsung Electronics (<http://www.samsung.com/ch/>) has pursued development cooperation with small and medium-sized robot manufacturing companies for next-generation low-cost manufacturing robots, and selected smart cars and artificial intelligent robots as next-generation core development. CHF 16.6 million was invested in JIBO, a company that manufactures social robots.

KT (<https://corp.kt.com/eng/>) and iRiver jointly developed 'Kibot', a smart education robot, and successfully commercialized it in Korea, and signed an export contract with Mobily, a mobile carrier in Saudi Arabia, for USD 2.2 million.

SK Telecom (http://www.sktelecom.co.kr/index_en.html) commercialized 'Albert', a smart educational robot, and 'Nuri Atti', an extended model of Albert. Also, the company has successfully launched 'Who', a smart speaker that provides interactive-based interaction, music playback, and smart home control.

LG (<http://www.lg.com/au>) introduced the Hub robot, which acts as a smart home gateway, at the CES 2017 exhibition, and a social robot that has a similar appearance and a driving part similar to the JIBO in the US. It also provides administrative functions such as music playback and schedule management. The US launched hub is based on Amazon's Alexa, providing voice-based services.

Bona Vision jointly developed 'TYCHE', a friend robot for the purpose of English education. It is a smartphone robot that is a revolutionary artificial intelligence robot that responds to 90% of Cambridge English (beginner level), and helping children to develop their intelligence by watching, listening and talking. Bona Vision has changed its name to AIBRAIN.

IPL (<http://www.ipl.global/>) developed 'IJINI', a social robot in 2016. The robot communicates through voice recognition, acts as a personal assistant to provide functions such as scheduling and alarm setting, and guards by conducting home monitoring and patrol, and also performs as an entertainer to play games, dance and sing together. It can provide various functions such as a role as a hub of a smart home for controlling household appliances, and a role of a communicator communicating with a human being through simple conversation. The company is leading the domestic social robot market due to signing a supply agreement with China of CHF 13.3 million in the second half of 2016.

YUJIN ROBOT (<http://en.yujinrobot.com/?override>) collaborates with Korea Electronics and Telecommunications Research Institute and Eulji University Hospital to develop high-load and low-load logistics robots that can be used in hospitals and nursing homes. In January 2015, in order to diversify its business, it entered the character toy business based on 'Robotrain RT' jointly with CJ E & M.

Hanwha Techwin (<http://www.hanwhatechwin.com/>) acquired Samsung Techwin in November 2014, and based on this, Hanwha Techwin is strengthening its unmanned robot business and developing new medical robots.

RF (<http://www.rof.co.kr/>) is a robot manufacturer specialized in window cleaning. The company has developed its 'Window Mate' product, a window cleaning robot that does not crash even when the power is shut down, a first time in the world for this kind of technology. In 2017, it signed an export contract with SODC, a Japanese company, for CHF 4.3 million.

Table 11: Major players in the robotics market

Category	Foreign companies	Korean companies
Housekeeping support: cleaning service, life support, home care	Electrolux, iRobot, Dyson, Robotics, Xiaomi	SAMSUNG Electronics, LG Electronics, YUJIN ROBOT, FINERBOTICS, RF, EVERYBOT, VARRAM, COREBELL
Social: toys, care, education, guide, secretary	SoftBank, Toyota, Mayfield Robotics, Asus, Ewaybot, InGen Dynamics, Blue Frog Robotics, NTT, Pillo Health, Anybots Inc, Zora Robotics	LG Electronics, YUJINROBOT, FUTUREROBOT, IPL, KT, SK TELECOM, ROBOCARE
Strength aids: Strengthening muscles, supporting muscle strength, understanding the will, power supply technology	Againer, ExoAtlet, Cyberdyne, Parker, Hannifin, ReWalk Robotics, Rex Bionics, Hocoma (CH), Lockheed Martin	HYUNDAI Robotics, LIG NEX1, SG MECHATRONICS, WALKBOT
Sports Simulator: Virtual Reality, Augmented Reality, Wearable Device, Sensor Device, Motion Platform, Interaction	Microsoft, Apple, Richo, Facebook, HTC, Sony, Nokia, GoPro, InvenSense, Intel, Xsens, Cyber Glove, Triax, K-vest	SAMSUNG Electronics, LG Electronics, MCNEX, KOREA MEDIA TECH, LG U+, SKT, PICOSNET
Logistics	Elodyne, SICK, Bosch, Hokuyo, Aethon, Swisslog (CH), JBT Corporation, Adept Technology, KIVA Systems, Panasonic, SRI, Evolution Robotics, iRobot	SAMSUNG Electronics, LG Electronics, YUJINROBOT, FUTUREROBOT, DRB Fatec, EO SYSTEM
Cooperative manipulator	Rethink Robotics, Universal Robots, KUKA, ABB (CH), Yaskawa, Denso, NEC, Matsushita Electric, FANUC, Kawasaki, Nachi, NEGUART	HYUNDAI Robotics, MOTOR NET INTERNATIONAL, ROBOSTAR, DSTROBOT, ROBOTECH
Medical rehabilitation	Hocoma (CH), Aretch LLC, Motek Medical, Motorika, Myomo, Reha Technology (CH), Kinetic Muscles, Reha-stim, Saebo, MediTouch	HYUNDAI Robotics, MCARE, MIRAE, CARE LINE, CYBORG LAB, HEXAR SYSTEMS

(Source: Strategies and Technology Roadmap for Small and Medium-Sized Enterprises in 2016)

8. Exhibitions and Related Organizations

1) Machine Tool Industry

- Seoul International Manufacturing Technology Show SIMTOS, April 3-7, 2018
http://www.simtos.org/user/eng/eng_index_main.jsp
- Korea Machine Tool Manufacturer's Association
<http://www.komma.org/komma/eng/Introduction.do>

2) 3D Printing Industry

- Inside 3D Printing Conference & Expo, June 27-29, 2018
<http://inside3dprinting.com/seoul/2017/>
- 3D Printing Industrial Association
<http://www.3dpia.org/default/>
- Korea 3D Printing Association
<http://www.k3dprinting.or.kr/>

3) Robotics Industry

- Robot World, October 10-13, 2018
<http://www.robotworld.or.kr/eng/>
- The 11th Gwangju International IOT/Robot Exhibition, July 5-7, 2018
<http://g-robot.or.kr/fairDash.do?hl=ENG>
- Korea Association of Robot Industry
<http://www.korearobot.or.kr/eng/>
- Korea Institute for Robot Industry Advancement
<http://www.k-robot.org/index.9is>

9. Conclusion / Call-for-Action

This report has reviewed the current status of three areas of the Korean MEM industry. We have also focused on the major trends of the industry and the contents that can be of interest for Swiss companies.

The Korean machine tool industry is expected to grow at a CAGR of 9.46% until 2019, and its size is expected to reach about CHF 16 billion. Thanks to Korean automobile, electronics, and machinery industries growing, the demand for equipment, components and new facilities in this area is exploding and the semiconductor industry in particular has invested USD 40 billion in 2017. The total imports of machine tools from Switzerland is about USD 82 million, about 7% of total imports, but it is the third largest after Japan and Germany. Machine tools are evolving toward multitasking, hybridization, and intelligence, but the demand for their products is changing to small-lot production, so Swiss companies should pay close attention to the trend in Korea. In the industrial field aerospace, medical, and biotechnology are growing in demand for Swiss company's market expansion.

The market size of the 3D printing system in Korea is estimated to be CHF 35 million up to 2013, and it is forecast the 3D printing market is growing highly till 2020. However, Korean companies occupy only 10% of the market and depend on overseas technology. Although Korean companies have a strong ability to respond to market trends to produce finished printers, they are not capable of manufacturing high-quality parts or modules because they are vulnerable to source technology or element technology. There are many opportunities for Swiss component companies to collaborate with those Korean companies.

The domestic market for the robotics is expected to grow about CHF 4 billion by 2019. In the future, the number of smart factories is expected to increase further due to developments in the Internet of Things and cloud computing, so the industrial robot market in Korea is expected to grow further. To enter into Korean market for Swiss companies with component technologies such as motors and speed reducers, they will need to collaborate with manufacturers of finished robots or automation equipment in Korea on the one hand, while a global company like ABB is expected to play a big role in building robot systems for customers in the manufacturing sector in Korea.

The Korean government has supported the manufacturing industry with the goal of building 10,000 smart factories by 2020. To this end, the production lines of developed countries to which various sensor technologies and information technologies are applied will be used as best practices. At this time, it would be easy to enter the market in Korea if Swiss products have been verified by the advanced automation factory in Europe.

The reputation for the quality of Swiss products is excellent, but the complaints about the after sales service are relatively large compared with Korean or Japanese products. Swiss companies better build a business system that can overcome the weaknesses of after sales service at the same time to have a high price advantage.

It is also recommended that Swiss companies closely manage communication with local business partners in Korea. Swiss companies should be more active in providing administrative support related to import and export so that Korean partner companies can benefit from the tariff, which is relatively lower to that of Japan. Thanks to Korea-EFTA FTA, Korean importing companies can enjoy a preferential tariff rate for Swiss products, differently from Japanese ones.

Swiss Business Hub Korea has supported Swiss companies to export in Korea, since the establishment in 2010. Any Swiss companies interested in opening a new market or expanding their market in Korea, SBH Korea can be a door opener for Korean market.

※ All financial data in this report is based on CHF converted from KRW figures. The applied exchange rate is CHF 1 = KRW 1,200.

[Appendix]

1. Korea Public Procurement Information

Procedures and methods for foreign companies to participate in public procurement tenders in Korea are as follows.

1) Companies wishing to participate in bidding shall register with the Korean Public Procurement Service PPS as a bidder and apply for certification.

- Required Documents

- a. Application for registration (as below)

국외소재업체 등록 신청서 (Application for Registration)

수신 : 대한민국 조달청장(To: Administrator PPS)		등번호 (DUNS Number)	
*회사명 (Name of Firm)		사업자등록번호 (Taxpayer ID No.)	
*대표자명 (Name of Chief Executive)		*E-mail	
*회사주소 (Address of Firm)		*전화번호(Tel. No.)	
		*팩스 번호(Fax No.)	
업태 (Type of Firm)	<input type="radio"/> 개인 / 법인 (Private Firm / Corporation)	소재국 (Country in which Firm is registered)	*개업일 (Open date for business)
		자본금 (Capital of Firm)	종업원수 (Number of Employees)
		최근 3년간 매출액 (Sales Records for past 3 years)	
입찰 및 계약서명권자 (Persons authorized to sign bids & contracts)	직위 (Job Title)	성명 (Name)	서명 또는 사용인감 (Signature or Seal)
*입찰참가 희망분류 (Products to be offered)	세부품명 (Detailed commodity)		세부품명번호 (Detailed commodity number)
*한국 내에서 연락가능한 대리인에 대한 기재사항을 기입해 주십시오 (Please fill out the mentioned items about your agent who is contactable in Korea.)			
<input type="radio"/> 대리인 이름 (Name of agent)		<input type="radio"/> 사무실 전화번호 (Office phone No.)	
<input type="radio"/> 휴대전화 번호 (Mobile phone No.)		<input type="radio"/> 팩스번호 (Fax No.)	
<input type="radio"/> 주소 (Address)			
<input type="radio"/> 이메일 (E-mail)			
*제출서류 (Required Document)		<input type="radio"/> 사업자등록증 또는 점포소유 증명서 (Certificate of Taxpayer's ID No. or Office Ownership)	

※ 본인은 상기회사의 합법적인 대표자로서 위의 모든 사항에 대하여 틀림없음을 확인하는 동시에 경쟁입찰참가자격 등록을 신청합니다.
 (I, as the legally authorized representative of the Firm, duly state that all of the above information is true and correct and hereby duly apply for registration.)

주-1. 제출서류는 신청자 소재국의 관할행정관서나 유관사업당국이 발행 또는 확인한 서류이어야 한다.
 (Attention-1. Documents to be submitted must be issued or authenticated by Government Agency or concerned authority of the Applicant's country.)

주-2. 모든 기재사항은 한국어로 작성되어야 하며, 제출서류의 원본이 한국어 이외의 언어로 작성된 경우에는 원본에 한국어 번역문을 공증을 받아 제출하여야 함.
 (Attention-2. This application form must be filled out in Korean. When the original documents are in a language other than Korean, they must be accompanied by a notarized Korean translation.)

*날짜

(Date)

*대표자명

(Name of Chief Executive)

*서명 또는 증명인감

(Signature or Seal)

Agreement on Collection and Use of Personal Information and Provision to Third Party

* I agree to the following terms of collection and use of personal information : I, the applicant(s) whose name(s) appears above, hereby agree that the Administrator of Public Procurement Service retain and use my personal information contained in this application until my registration is terminated or cancelled, for the purpose of registration of firm and "procurement tasks" provided for in Article 2 Paragraph 3 of Act on the Use and Promotion of Electronic Public Procurement. I will not object to or challenge the denial of registration by Public Procurement Service on the basis of my non-agreement to this terms of collection and use of personal information.

I agree to the following terms of provision of personal information to third party : I, the applicant(s) whose name(s) appears above, hereby agree that the Administrator of Public Procurement Service provide my personal information contained in this application, until my registration is terminated or cancelled, to "procuring entities" provided for in Article 2 Paragraph 1 of Act on the Use and Promotion of Electronic Public Procurement, for the purpose of "procurement tasks" provided for in Article 2 Paragraph 3 of the same Act. I will not object to or challenge the denial of registration by Public Procurement Service on the basis of my non-agreement to this terms of provision of personal information to third party.

Please check the boxes to confirm your Agreement on Collection and Use of Personal Information and Provision to Third Party

Fields marked with asterisks [*] are required fields

- Cost:
 - Electronic certificate issuing cost: approx. CHF 20
- How to apply for a PPS bidder certificate
 - a. Fill out the application form
 - b. E-mail address: enter the e-mail address in the application form. Typos or omitting the e-mail address may result in failure to receive relevant information from PPS.
 - c. Korean agents or contact points: if the applicant does not have a Korean agent or contact point, this section can be left blank.
 - d. Enclose the original Certificate of Taxpayer's ID No. or Office Ownership. These documents must be translated in Korean and certified by a notary public.
- Where to submit the document
 - Applicants may send the application form and enclosed documents by post-mail to PPS customer support team in Korea.

Table 12: Where to submit your application

Office	Phone	Fax	Address
PPS Customer Support Team	(82)42-481-7144	(82)42-472-2297	PPS Customer Support Team, Government Complex-Daejeon city, Republic of Korea, 35208

(Source: www.pps.go.kr)

- 2) Receive bidder's ID, password and digital certificate.
 - If the applicant is qualified to be a PPS bidder and pay the fee for e-certificate issued by the certification agency (KICA Inc.), a PPS Registration ID and a copy of the certificate will be issued and mailed to the applicant's e-mail address along with a temporary password.
- 3) Access the website where the bidding is going and participate in the bid. (Refer to the attached manual)
 - Upon receipt of the PPS ID and temporary password, system registration procedure on-line should be followed to participate in PPS tenders. Log on to PPS official website for system registration as follows.
 - <http://www.pps.go.kr/eng/jsp/information/tender/foreign.eng>

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