Part I

The Opening of a New Era in Land, Infrastructure, Transport and Tourism Administration through Innovation

Chapter 1 Development and Innovation in Japan

Based on the premises of discussions to follow in Chapter 2 and later sections, Chapter 1, "Development and Innovation in Japan," looks at the importance of innovation-driven economic growth, with an awareness of the difficult circumstances of the Japanese economy and the challenges it faces.

Japan is an "advanced nation" when it comes to facing a variety of challenges, including a falling birthrate and aging population as well as a severe fiscal situation. Given that background, Section 1, "The Environment and Socioeconomic Situation Surrounding Japan," outlines the need for innovation and the fact that, if this need is taken in a positive way, it is a chance for innovation-driven progress and development.

Next, Section 2, "The State of Innovation in Japan," reviews Japan's innovation policy to date and Japan's strengths and weaknesses with regard to innovation, focusing on the Basic Act on Science and Technology and the Science and Technology Basic Plan.

Section 3, "The History of Innovation," first looks at the Industrial Revolution as an example that brought major changes in living, the economy, and society. It then surveys the history of development in the field of transportation, which is deeply relevant to the fields of land, infrastructure, transport, and tourism. It then looks back on the history of the diverse cases of innovation in the world in recent years and cases of innovation that were advanced by Japan.

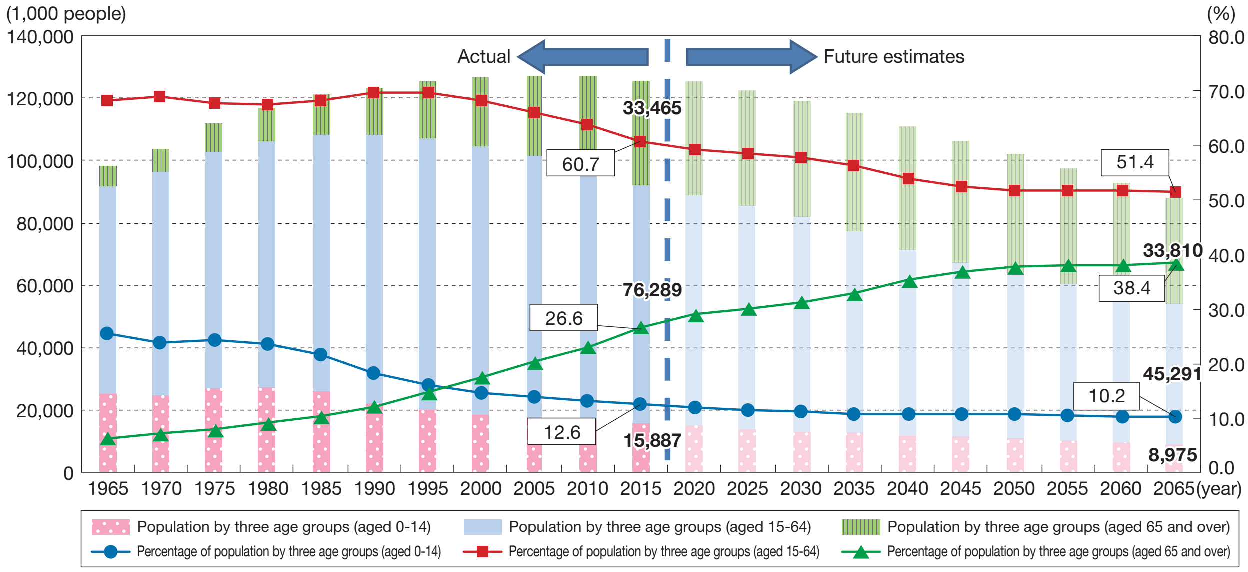
Section 1 The Environment and Socioeconomic Situation Surrounding Japan

1 Japan's Socioeconomic Situationx

(1) An Aging Society with a Declining Birthrate and Population Decline

As its birthrate declines and its population ages, Japan's total population has been falling, after peaking in 2008, with the productive-age population also decreasing after peaking in 1995. According to a projection by the National Institute of Population and Social Security Research (median projection for birth/death), the total population is projected to decline to 88,080,000 in 2065, with the productive-age population (15 – 64 years of age) projected to decline to 45,290,000 in 2065 (Figure 1-1-1).

Figure 1-1-1 Trend in Japan's Population



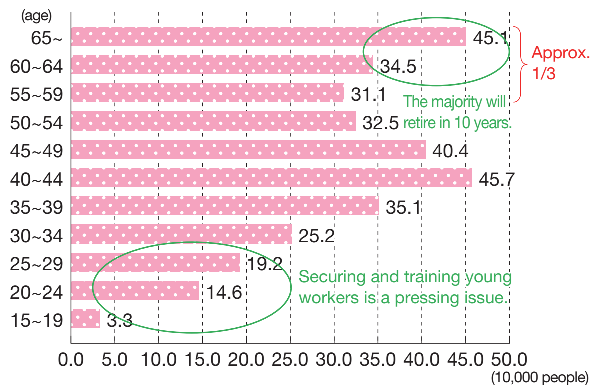
(Note) Okinawa Prefecture is not included for dates up to 1970.
Source) "National Census Report" by the Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) for dates up to 2010, "Basic Complete Tabulation on Population and Households of the 2015 Population Census" by Statistics Bureau of MIC for 2015 data; estimates are calculated by the MLIT from the median estimates of birth (median estimates of death) in "Japan's future population estimates" (estimates from 2017) by the National Institute of Population and Social Security Research (IPSS).

Looking at fields related to the Ministry of Land, Infrastructure, Transport and Tourism, in the construction field, workers aged 55 and older account for around a third of the approximately 3,260,000 skilled workers at construction sites (as of 2016). This is one example of the aging of workers (Figure 1-1-2).

Furthermore, in the face of the possibility of older workers leaving the workforce in large numbers in the future, there are concerns that a labor shortage will occur in the medium- to long-term.

In the traffic and transportation field as well, there are concerns over a shortage of skilled workers and the succession of skills in different areas such as rail, automobiles, shipbuilding, marine transport, ports and harbors, aviation, and logistics.

Figure 1-1-2 Forecast of Older Workers Leaving the Construction Industry in Large Numbers



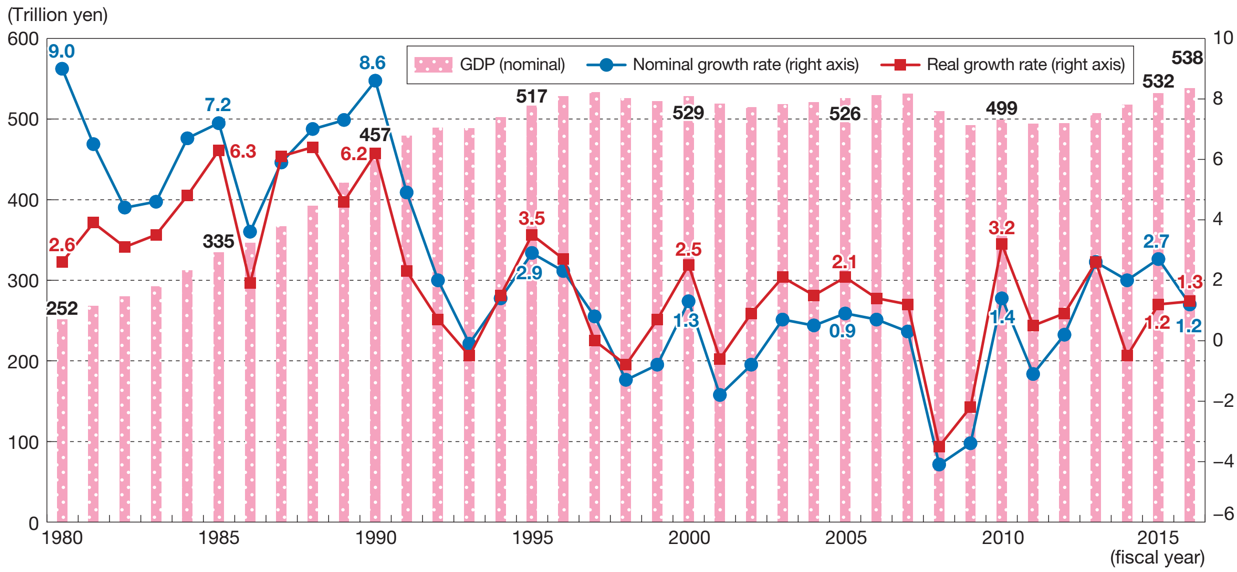
Source) Prepared by the MLIT based on the "Labor Force Survey" by MIC

In order to overcome these kinds of supply restrictions and labor shortages associated with a declining population, there is a need to increase productivity through innovation, in addition to further training workers.

(2) A Decelerating Growth Rate

GDP movement in FY2016 was solid, with positive growth rates for both nominal and real GDP. Looking at the medium- to long-term, the GDP growth rate in recent years has transitioned generally around 0 – 2% since the 1990s (Figure 1-1-3).

Figure 1-1-3 **Trend in Japan's GDP**



Notes) Gross domestic product from "Fiscal 2009 National Accounts (2000 basis, 93SNA)" for FY1980 to FY1993 (year-on-year change: FY1981 to FY1994) and from "Quarterly Estimates of GDP for January – March 2017 (First Preliminary Estimates) (2011 basis, 08SNA)" for FY1994 (year-on-year change: FY1995) and later. Total figures for dates before FY1993 have been processed to connect them to figures with a different basis.

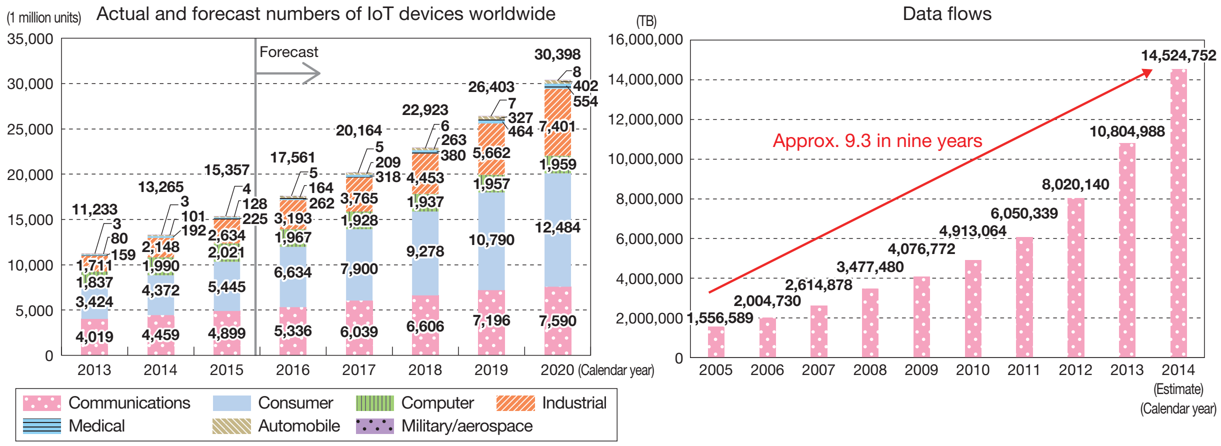
Source) Prepared by the MLIT based on the "Annual Report on the Japanese Economy and Public Finance FY2016 (Long-term Economic Statistics, National Accounts of Japan (1/5))" by the Cabinet Office and "National Accounts of Japan (GDP Statistics)" by the Cabinet Office.

(3) Substantial Progress in Science and Technology

Science and technology has achieved substantial progress in a variety of fields in the 21st century. Progress in information and communications technology (ICT) has been especially remarkable, and we have entered an era where all kinds of things, including people, information, goods, and capital, are connected and affect each other instantaneously in a global environment. On the back of progress in ICT, robots and AI[Note 1] are now used in industry and all kinds of life situations, including in familiar products and services, and it is hoped that this will lead to improved productivity and a resolution of labor shortages. Also, advances such as IoT[Note 2], which connects various kinds of information and goods through the Internet, are also taking place (Figure 1-1-4).

Note 1 Artificial Intelligence
Note 2 Internet of Things

Figure 1-1-4 Science and Technology Progress, Such as in ICT



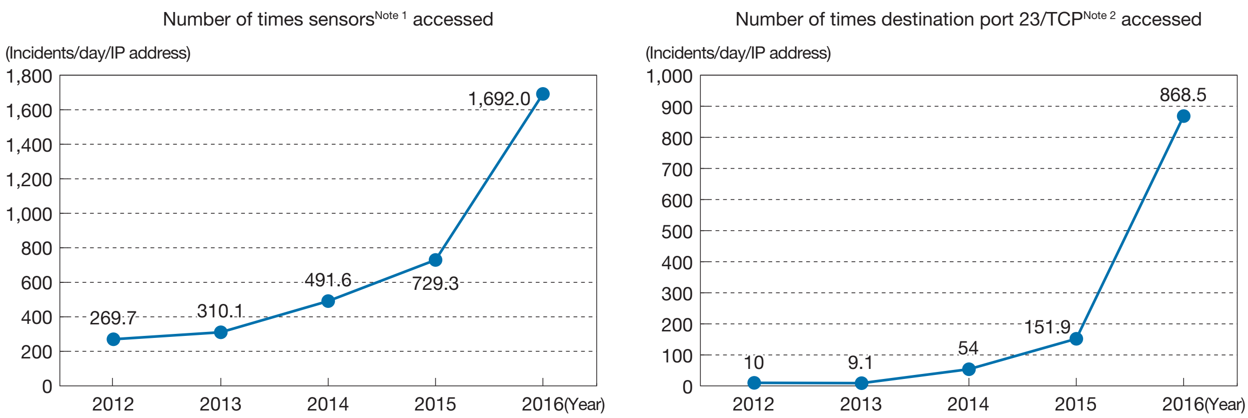
(Notes) 1 IHS Technology defines an IoT device as any device that has a unique IP address and can connect to the Internet. This covers a wide range of electronic devices, from sensor network terminals to devices with computing functions.
2 Military/aerospace: Devices for military and aerospace applications (e.g., electric equipment and instrumentation for airplane cockpits, devices for passenger systems, and military surveillance systems)
Automobile: Devices in an automobile's control system and information systems that can connect to the Internet
Medical: Devices for medical treatment in addition to diagnostic imaging units as well as consumer healthcare devices
Industrial: Devices for industrial applications including automation (IA/BA), as well as non-automation uses such as lighting, energy-related, security, and testing and measurement instruments
Computer: Computing devices such as note PCs, desktop PCs, servers, work stations, main frames, and super computers
Consumer: Home electronics (white goods, digital products), PC peripherals such as printers, portable audio equipment, smart toys, and sports/fitness devices
Communications: Wireless communications infrastructure and terminals such as fixed communications infrastructure and network devices, 2G/3G/4G cellular communications devices, and Wi-Fi/WiMAX devices

Source) Prepared by the MLIT based on IHS Technology

Source) Prepared by the MLIT based on "Estimates of Big Data Flows and Research Study into the Actual Application of Big Data" (March 2015) by MIC

On the other hand, the rapid progress of ICT has been accompanied by increasing and increasingly sophisticated cyber attacks, threatening the lives of all citizens and socioeconomic activity (Figure 1-1-5).

Figure 1-1-5 Probing in Cyberspace

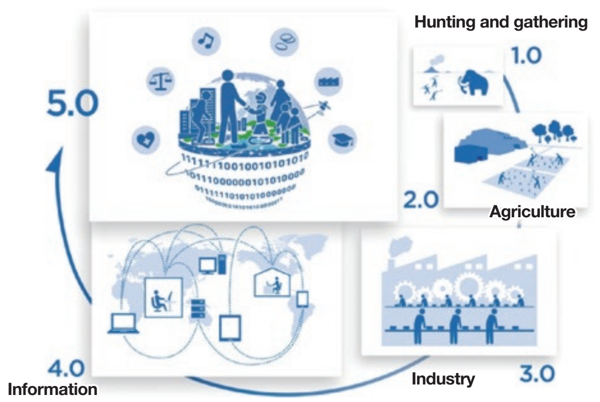


(Notes) 1 Sensors installed at points of connection with the Internet in a real-time detection network system operated around the clock by the National Police Agency. These sensors detect connection information that is not envisaged with normal Internet use, including probing for attempting various attacks, and the information is aggregated and analyzed.
2 A port used in Telnet service that enables remote control through command input.

Source) Prepared by the MLIT based on "Condition of Threats Surrounding Cyberspace in 2016" by the National Police Agency

Given this situation, the Japan Revitalization Strategy 2016 stated that "The 'fourth industrial revolution,' which uses the technological breakthrough of IoT (Internet of things), big data, artificial intelligence and robot sensors is the most important key to leading a future revolution in productivity." In addition, the Fifth Science and Technology Basic Plan sets out a vision of a "super smart society" (Society 5.0)Note 3 by extending the flow of transformation to society (Figure 1-1-6).

Figure 1-1-6 Image of Society 5.0



Source) Prepared by the MLIT based on "GDP of 600 Trillion Yen: STI Policies for Society 5.0" by the Council for Science, Technology and Innovation (CSTI)

2 Issues Facing Japan

(1) Imminent Massive Earthquakes and Increasingly Severe Weather Disasters

Due to such features as its geographic, topographic, and climatic conditions, Japan has undergone numerous disasters since ancient times. In recent years as well, it has experienced frequent disasters including earthquakes, tsunamis, volcanic eruptions, typhoons, floods, torrential rain and heavy snowfall (Figure 1-1-7).

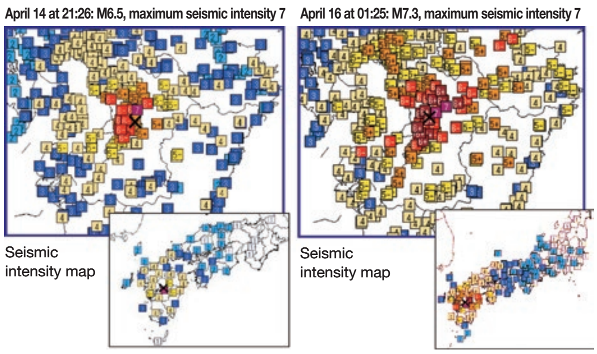
Figure 1-1-7 Main Disasters in Recent Years

- Great East Japan Earthquake of 2011
- Torrential rain (sediment-related disaster) in Hiroshima in August 2014
- Mt. Ontake eruption on September 27, 2014
- Torrential rain (Kinugawa River breach) in Kanto and Tohoku regions in September 2015
- Kumamoto Earthquake of 2016

Source) MLIT

The imminence of major earthquakes has been pointed out, including a Tokyo Inland Earthquake, which would strike the capital region directly, and a mega earthquake in the Nankai Trough, such as a Tokai, Tonankai, or Nankai earthquake, which could cause strong shaking and large tsunamis, mainly along the Pacific coast from Eastern Japan to Kyushu. During the Kumamoto Earthquake of April 2016, a maximum seismic intensity of 7 was recorded on the 14th and the 16th (Figure 1-1-8), causing a sediment-related disaster due to extensive slope failure and damage due to the collapse of buildings.

Figure 1-1-8 Kumamoto Earthquake of 2016 (Seismic Intensity Map of an Earthquake That Recorded Maximum Seismic Intensity of 7)



Source) Japan Meteorological Agency

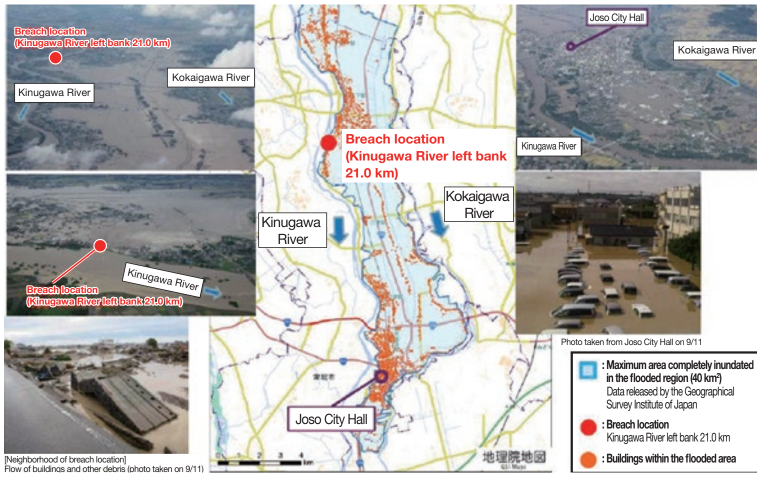
Also, Japan is one of the world's few volcanic countries, and once an eruption occurs, there is concern that the damage could be prolonged and that it could have a tremendous effect on the lives of residents and on socioeconomic activity. In 2014, the eruption of Mt. Ontake took the lives of over 50 people.

Looking at the weather, rain has become more localized, concentrated, and intense with climate change in recent years such that, for example, the number of incidents of severe rain in a short period (rainfall of 80 mm or more per hour) has increased by 1.5 times over the past 30 years. In August 2014, a local downpour in a short period caused a large-scale sedi-

Note 3 According to the Fifth Science and Technology Basic Plan, a super smart society is "a society in which the various needs of society are finely differentiated and met by providing the necessary products and services in the required amounts to the people who need them when they need them, and in which all the people can receive high-quality services and live a comfortable, vigorous life that makes allowances for their various differences such as age, sex, region, or language." Also, Society 5.0 "has the meaning of science, technology, and innovation ushering in transformations that create a new kind of society to follow on from hunting-and-gathering society, agrarian society, industrial society, and information-oriented society."

ment-related disaster in Hiroshima. During torrential rain in the Kanto and Tohoku regions in September 2015, a levee on the Kinugawa River was breached, causing major damage in Ibaraki (Figure 1-1-9). Rainstorms and torrential rain from June to September 2016 caused major damage in the Hokkaido, Tohoku, and Kyushu regions.

Figure 1-1-9 Torrential Rain in Kanto and Tohoku in September 2015



Source) MLIT

(2) Accelerating Aging of Social Infrastructure

Japan's social infrastructure, which was intensively developed during and after the period of high economic growth, is aging. Assuming that the maintenance conditions achieved using current technology and arrangements continue generally as-is, the maintenance and renewal expenses for social infrastructure under the jurisdiction of the MLIT are calculated to increase from approximately 3.6 trillion yen in FY2013 to around 4.6 – 5.5 trillion yen 20 years later (Figure 1-1-10). There is a need to balance securing the safety of existing social infrastructure with reduction and leveling of total costs for maintenance and renewal.

Figure 1-1-10 Maintenance and Renewal Expenses and Aging of Social Infrastructure

Estimated Costs of Maintenance/ Management and Renewal

Fiscal year	Estimated result
FY2013	About 3.6 trillion yen
FY2023 (In 10 years' time)	About 4.3-5.1 trillion yen
FY2033 (In 20 years' time)	About 4.6-5.5 trillion yen

*1. The number of facilities in each of the 10 fields of social infrastructures (roads, flood control, sewer systems, ports and harbors, public housing, parks, coasts, airports, aids to navigation, governmental facilities) over which the MLIT has jurisdiction and that are managed by the state, local public entities, Regional Road Public Corporations or Japan Water Agency, or an incorporated administrative agency, has been checked by year of initial construction for estimation, with records of their maintenance/ management, renewal, etc. taken into account.
*2. New construction and removal are not considered because they are difficult to estimate.
*3. Regarding functional improvements when renewing facilities, the assumption is to renew with similar functions (however, improvements to meet quake-resistance standards and the like are included).
*4. Does not include the land cost and compensation cost, natural disaster relief expenditure.
*5. Since maintenance and renewal unit cost and renewal timing vary among social infrastructure for such reasons as differences in the degree of damage stemming from conditions in different locations, the estimations are shown as ranges.

Present Status of Aging Social Infrastructures

<<Percentage Ratios of Social Infrastructure over 50 Years Old>>

	March 2013	March 2023	March 2033
Highway bridges [About 400 thousand bridges[Note 1)] (of 700 thousand bridges at least 2 m long)]	About 18%	About 43%	About 67%
Tunnel [About 10 thousand tunnels[Note 2)]]	About 20%	About 34%	About 50%
River management facilities (such as sluices) [About 10 thousand facilities[Note 3)]]	About 25%	About 43%	About 64%
Sewage pipes [Total length: about 450 thousand km[Note 4)]]	About 2%	About 9%	About 24%
Harbor quays [About 5 thousand facilities[Note 5)] (at least 4.5 m in water depth)]	About 8%	About 32%	About 58%

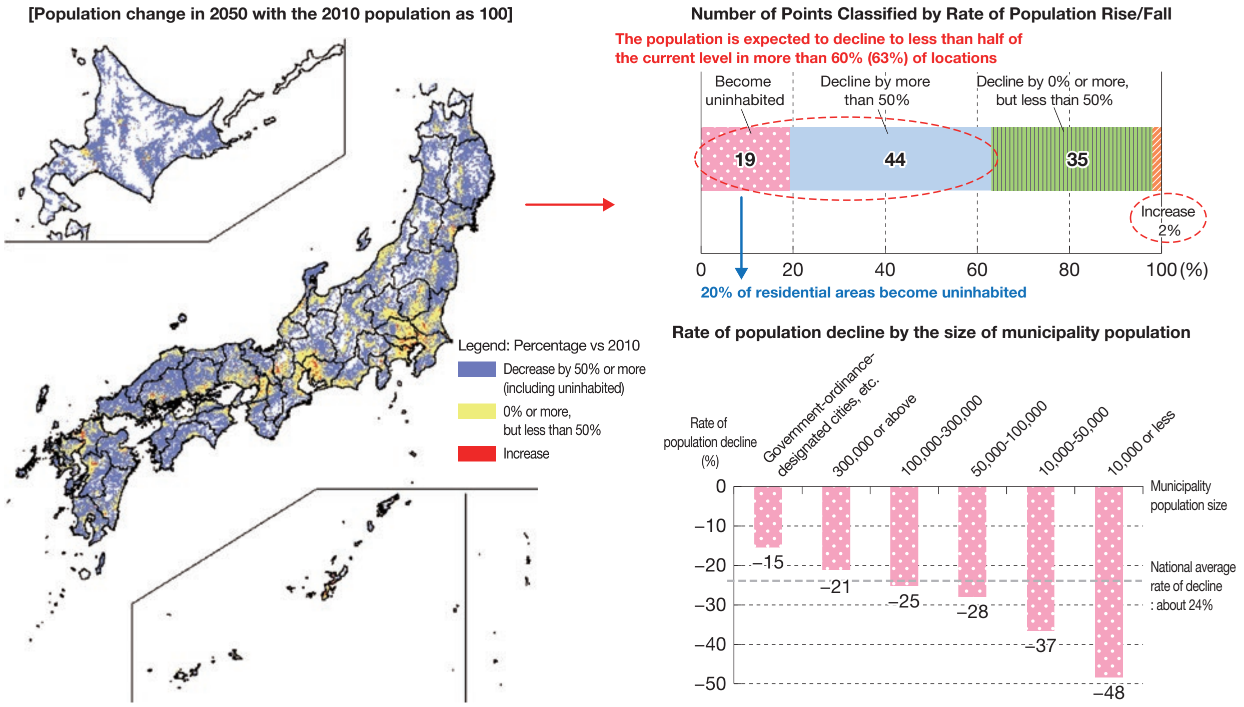
Note 1) About 300,000 bridges whose year of construction is unknown have been excluded from the ratio calculations.
Note 2) About 250 tunnels whose year of construction is unknown are excluded from the calculation of ratios.
Note 3) Government-managed facilities only, including about 1,000 facilities whose year of construction is unknown. (Since the facilities developed within the last 50 years generally have a documented history, the facilities whose year of construction is unknown have been sorted as being 50 years or older.)
Note 4) The figure includes approximately 15,000 km whose year of construction is unknown (since pipes laid within the past 30 years generally have records, pipes whose year of construction is unknown are treated as those aged 30 years or over and their length proportionally distributed in the ratio of construction by documented number of years elapsed.)
Note 5) About 100 quay facilities whose year of construction is unknown are excluded from the calculation of ratios.

Source) MLIT

(3) Exhaustion of the Countryside

As Japan transitions into a society whose population is in serious decline on a nationwide level, population decline will become especially noticeable in the countryside. According to medium- to long-term demographic forecasts, the populations of around 60% of regions across the country will drop to less than half in 2050, creating the crisis of a vanishing countryside. The envisioned effects of continued population decline include the reduction in services related to daily living; fewer employment opportunities; declines in the level of government-provided services due to lower tax revenues; withdrawal/reduction in regional public transportation; increase in the number of vacant houses, vacant stores, old factory sites, parcels of deserted arable land; and a decline in the functioning of local communities. It is thought that the different effects of population decline could create a vicious cycle that leads to further population decline through a drop in the convenience of everyday living and a drop in a community's attractiveness (Figure 1-1-11).

Figure 1-1-11 Simultaneous Decline and Regional Skewing of Population Densities Occurring Nationwide (2010 → 2050)

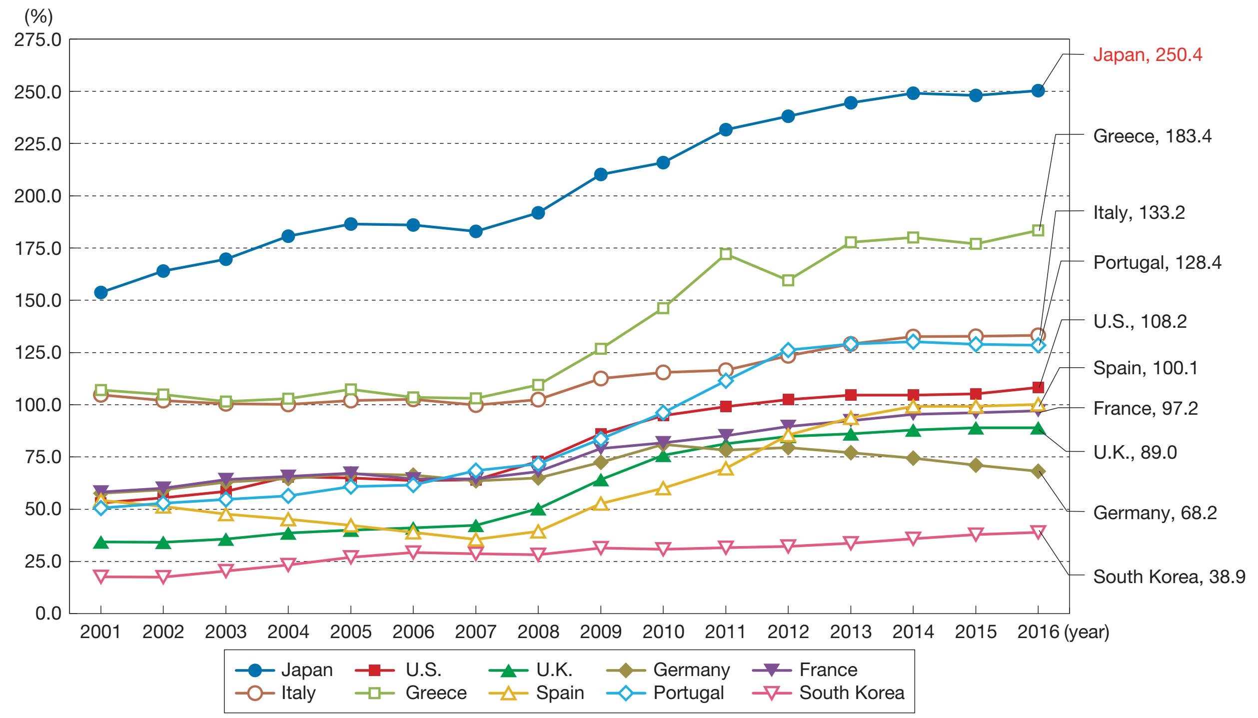


Source) "Grand Design of National Spatial Development towards 2050, Japan" by the MLIT (developed by the "National Census Report" by MIC and estimates by National Spatial Planning and Regional Policy Bureau at the MLIT)

(4) Financial Situation

Outstanding debt as a percentage of GDP is an indicator of the size of a nation's debt compared to the size of its economy. As such, it is an important indicator of fiscal health. Compared to other countries, outstanding debt as a percentage of GDP for Japan's national and local governments combined is in the severest situation. Going forward, the country will need to cope with the various challenges mentioned above while efficiently allocating limited fiscal resources (Figure 1-1-12).

Figure 1-1-12 International Comparisons of Outstanding Debt Balances (Debt–to-GDP)



Note) Figures are on a general government basis
Estimates for Japan from 2015 and later; estimates for other countries for 2016.
Source) Prepared by the MLIT based on the "World Economic Outlook Database, October 2016" by the IMF

3 Need for Innovation

As we have seen thus far, Japan must prepare for imminent and increasingly severe disasters, cope with the accelerating aging of infrastructure, revitalize its regions, and develop competitive conditions for beating fierce international competition all under the constraints of a decreasing population, a declining birthrate with an aging population, plus an associated falling productive-age population, and a severe financial situation.

Within this situation, a fourth industrial revolution, typified by such things as IoT, big data, AI, and robot sensors, has been moving ahead globally in recent years. The socioeconomic modality, including ways of working and lifestyle, not just economic activity in the form of production and consumption, is on the verge of major changes. Japan needs to seize on this global trend, create innovation, and implement the innovations created throughout the world, including Japan, in society so as to exponentially increase productivity, overcome a multitude of challenges, and achieve continued economic growth.

(1) Solving Issues through Innovation

As the maxim "Necessity is the mother of invention" goes, the existence of a challenge is thought to become an impetus for the creation of innovation.

In the construction, traffic and transportation fields, for instance, there are concerns about a future labor shortage, but this can also be taken as a good opportunity to create a construction industry and a traffic and transportation industry with extremely high productivity ahead of the rest of the world by creating innovation that makes use of things such as AI and IoT, which are undergoing dramatic evolution.

Furthermore, thinking broadly about the falling birthrate and aging population, the potential market size of the silver economy is quite large, with potential demand for such things as nursing-care robots, self-driving cars, practical use of AI, and application of big data to medical care. Also, demand for services and products designed for an aging society is anticipated to increase around the world. It is therefore conceivable that the international expansion of new products and services created in Japan could lead to continued growth of the Japanese economy.

In order for created innovation to be embraced by society, people's worries about new technologies and services must be dispelled. In Japan, while there are those who regard the safety of self-driving cars, for example, with apprehension, there are also people looking forward to major effects such as the securing of transportation in daily life for mobility-impaired persons and the reduction of congestion and traffic accidents. Given that Japan is an "advanced nation" when it comes to facing challenges, it could also have an environment conducive to fostering social acceptance of innovation.

(2) Economic Effects of Innovation

Below, we look at the economic effects of innovation in terms of supply and demand.

(Innovation's effect on demand generation)

Demand generation, such as through the provision of new goods and services and a decline in prices, can be expected as an economic effect of innovation.

For example, according to the "2016 White Paper: Information and Communications in Japan" by the Ministry of Internal Affairs and Communications[Note 4], the demand generation effect has been estimated for new ICT services (Figure 1-1-13). The area with an especially large demand generation effect is that of service robots, with a maximum effect of approximately 560 billion yen. This is followed by smart homes (with monitoring features and energy features), with estimated effects of about 190 billion yen and 160 billion yen, respectively, and connected cars (with automated driving functions), with an estimated effect of approximately 120 billion yen. A large demand generation effect is also anticipated for new services related to the fields of land, infrastructure, transport, and tourism.

Figure 1-1-13 Estimated Economic Effects

	Potential users*1		Percentage intending to use paid services*2		Amount willing to pay (monthly, in yen)*3		Economic effect (direct impact, billions of yen)
Connected cars (with insurance telematics)	51.84 million households	×	13.4% – 13.7%	×	661 – 692	=	56.3 – 57.7
Connected cars (with automated driving functions)	51.84 million households	×	18.3% – 19.1%	×	918 – 1,030	=	104.5 – 119.8
Smart homes (with energy features)	51.84 million households	×	12.2% – 13.0%	×	1,732 – 1,913	=	131.4 – 154.7
Smart homes (with monitoring features)	51.84 million households	×	17.1% – 18.1%	×	1,685 – 1,734	=	183.4 – 189.9
Wearable devices	47.18 million (smartphone users)	×	13.4% – 13.5%	×	613 – 617 15,000	=	46.5 – 47.1 100.7 – 101.4
Service robots	33.28 million households (households owning smartphones)	×	10.9% – 15.5%	×	16,693 – 16,995	=	377.1 – 564.9
Personal or household ICT education services	33.28 million households (households owning smartphones)	×	15.7% – 15.6%	×	448 – 468	=	28.1 – 30.4
Personal or household ICT medical services	33.28 million households (households owning smartphones)	×	15.7% – 16.5%	×	1,085 – 1,159	=	71.5 – 72.7
Personal ICT financial services	47.18 million (smartphones users)	×	9.9% – 13.3%	×	645 – 797	=	42.6 – 48.6
Ultra HD video streaming services	51.84 million households	×	17.3% – 18.5%	×	337 – 359	=	38.5 – 38.8
Sharing services	47.18 million (smartphones users)	×	8.8% – 12.8%	×	300	=	14.9 – 21.7

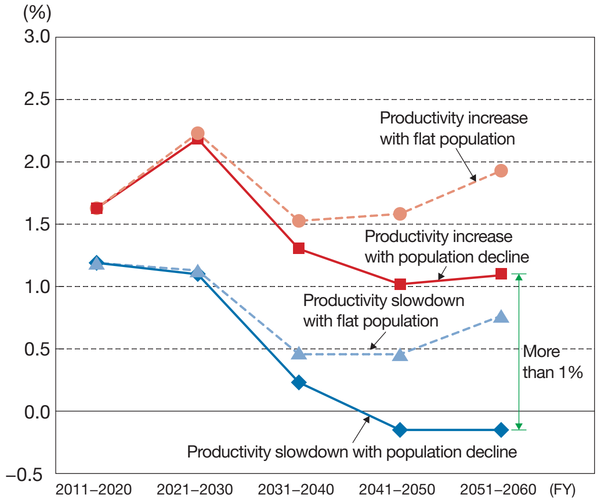
*1: This column shows the potential user base (households / individuals) according to the nature of the service or application. When services and applications are expected to work with smartphones or other devices, the potential user base is limited to those users.
*2: These figures are based on a survey given to consumers. (The upper and lower figures are the result of multiple functions presented to the respondents.)
*3: These figures are based on a survey given to consumers. For connected cars, ICT education, ICT medical, and ultra HD video streaming services, respondents were asked by what percentage their expenditures would increase from their current household expenditures on the same service or application. The figures here were calculated by multiplying expenditures by this percentage.
Source) Prepared by the MLIT based on "Study Report on a Structural Analysis of the ICT Industry in the IoT Era and Verification of ICT's Multifaceted Contributions to Economic Growth" (2016) by MIC

Note 4 In the "2016 White Paper: Information and Communications in Japan" by MIC, the demand generation effect was calculated by seeking the percentage with an intention to use and the amount willing to pay for new ICT services based on the results of a consumer survey. The survey asked about new services and applications envisioned to be available by 2020 across the whole breadth of ICT.

(Economic growth from innovation)

Considering the impact of innovation in terms of supply, it is expected to contribute to the improvement of productivity through the routes of increasing the operating rate of existing equipment, streamlining operations, and improving capital productivity[Note 5]. According to a report by the Council on Economic and Fiscal Policy, Expert Panel, Committee for Japan's Future, an approximately 1% difference in real GDP growth rates appears between the scenarios of increasing productivity versus a slowdown in productivity with population decline (Figure 1-1-14). It is thought that going forward, economic growth is achievable even with a declining population, as long as increased productivity can compensate for the negative factor of a declining workforce.

Figure 1-1-14 Estimates of Future Population and Real GDP Growth Rate



(Note) Scenario assumptions
Flat population: (i) Total fertility rate increases to 2.07 in FY2030 and is maintained at the same level thereafter; (ii) population in 50 years' time is maintained at around 100 million
Population decline: (i) Total fertility rate declines to 1.33 by FY2024 and is maintained at about 1.35 thereafter; (ii) population in 50 years' time decreases to about 85 million
Productivity increase: TFP increases to around 1.8% by the beginning of the 2020s
Productivity slowdown: TFP increases only around 1.0% at the beginning of the 2020s
Source) Prepared by the MLIT based on the "Growth and Development Working Group Report" by the Council on Economic and Fiscal Policy, Expert Panel, Committee for Japan's Future

Column

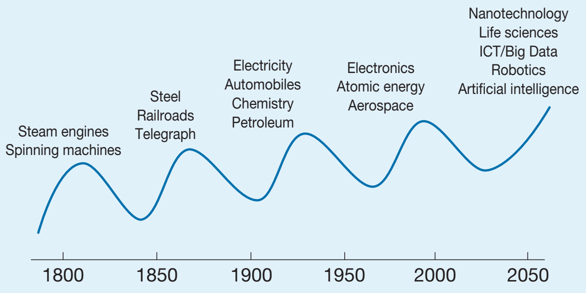
Economic Cycles and Innovation

Schumpeter attempted to explain Kondratieff's theory of long-wave cycles in terms of the concept of innovation. Kondratieff's first wave lasted from the end of the 1780s to the beginning of the 1850s, the second from the beginning of the 1850s to the 1890s, and the third from the 1890s to approximately the 1920s. As Schumpeter explains, these phenomena can be understood in terms of the first wave being based on the industrial revolution and the process of its spread, the second being based on the construction of railroads centered on steam engines and the age of steel; and the third being the age of electricity, chemistry, and automobiles, brought about by the second industrial revolution. In other words, it is believed that significant inventions prevailed over previous technologies and were incorporated into businesses, spreading from one sector to another, attracting new investment, and causing clusters of new business management techniques and new industries to spring up, and bringing about long-term growth.

There are also those who believe that we are currently in a fourth wave and that in the future, nanotechnology, the life sciences, big data, robotics, and artificial intelligence will drive the rise of a fifth wave.

Note 5 According to "Japanese Economy 2016-2017" (January 2017) by the Cabinet Office, the first is the rise in productivity from increasing the operating rate of existing equipment. Such things as accurate ascertainment of the operational status of equipment, refinement of demand forecasting using big data, and improvement in the matching of users (consumers) and providers (suppliers) using sharing services are all thought to lead to higher productivity through increases in the operating rate of equipment. The second is the rise of productivity from the streamlining of operations by making use of such things as big data and AI. It is possible that the use of AI could be substituted for brainwork, which is regarded as a high skill, not just for back office work and some unskilled labor, increasing labor productivity as a result. The third is the possibility that the use of the Cloud and the establishment of distributed systems could produce capital investment savings, thereby improving capital productivity. Particularly with regard to financial services, such things as the introduction of block chain technology could make it easier to establish means of settlement and ensure safety without making enormous systems investment in existing equipment.

Figure 1-1-15 Economic Waves and the Innovations That Undergirded Them



Source) Nikkei Business

Section 2 The State of Innovation in Japan

1 Innovation Policy in Japan to Date

(1) Council for Science, Technology and Innovation

(Council for Science, Technology and Innovation)

The Council for Science and Technology Policy was set up in the Cabinet Office as one of the councils for key policies during a reorganization of government ministries and agencies in January 2001. It was reorganized into the Council for Science, Technology and Innovation[Note 6] in May 2014 to strengthen the functions related to the creation of innovation. Under the leadership of the Prime Minister and the Minister of STI Policy[Note 7], the Council for Science, Technology and Innovation serves as the headquarters for the promotion of STI policy; it overlooks all of the nation's science and technology, formulates comprehensive and basic policies, and conducts their overall coordination.

(CSTI's roles)

The roles of the CSTI are as follows:

(i) Investigate and discuss basic policies concerning science and technology
"The Science and Technology Basic Plan" (every five years), "Comprehensive Strategy on Science, Technology and Innovation" (annually)

(ii) Investigate and discuss science and technology budgets and the allocation of human resources
"Comprehensive Strategy on Science, Technology and Innovation" (annually)

(iii) Assess nationally important research and development
Evaluation and follow-up of large-scale R&D, "General Guidelines for Evaluating Government Funded R&D"

(iv) Decide other key issues surrounding the promotion of science and technology
Decision-making regarding such programs as the "Strategic Innovation Promotion Program" (SIP[Note 8]) and the "Impulsing Paradigm Change through Disruptive Technologies Program" (ImPACT[Note 9])

Note 6 CSTI
Note 7 Officially the Minister of State for Science and Technology Policy
Note 8 Cross-ministerial Strategic Innovation Promotion Program
Note 9 Impulsing Paradigm Change through Disruptive Technologies Program

(2) The Science and Technology Basic Plan

Under the Basic Act on Science and Technology, which was enacted in 1995, Japan has formulated a science and technology strategy, with a long-range outlook, in a Science and Technology Basic Plan (Basic Plan) every five years[Note 10] and has made efforts to promote science and technology.

Given a context including economic slowdown, intensification of international competition, and increasingly serious global issues, expectations have mounted since the latter half of the 2000s for innovation creation that could produce new value through unprecedented frameworks. In that sense, the 3rd Basic Plan talked about "creating scientific development and persistent innovation."

The 4th Basic Plan highlighted the "integrated development of S&T and innovation policies" as a basic plan of action. Under this basic principle, a Comprehensive Strategy on Science, Technology and Innovation has been formulated every year since 2013 with the purpose of promoting innovation comprehensively.

The 5th Basic Plan, which is the first plan devised by the CSTI, says that STI policy will be promoted forcefully. The plan is positioned as one to be implemented by a wide spectrum of parties—including the government, academia, industry, and citizens—working together. The plan says that it will guide Japan toward becoming "the most innovation-friendly country in the world."

Surveying the status of innovation policies in other countries over the past 20 years, we see that countries such as the U.S., the U.K., and France, have positioned STI policy as key national polices since the latter half of the 1990s, and have continued to strengthen them since then (Figure 1-2-1).

Note 10 The past Basic Plans formulated were the 1st (FY1996 – FY2000), the 2nd (FY2001 – FY2005), the 3rd (FY2006 – FY2010), and the 4th (FY2011 – FY2015). The Cabinet approved the 5th Basic Plan (FY2016 – FY2020) on January 22, 2016.

Figure 1-2-1 Changes and Trends in STI Policies in Major Countries

	U.S.	U.K.	Germany	France	China	South Korea
Back-ground and features of S&T policies	S&T power strengthened through military demand	Although traditionally focused on S&T, in light of attrition of the research base, national R&D investment was maintained while annual expenditure overall was on the decrease.	Authority is not centralized, but distributed to research institutions. Private R&D is also active.	Public research institutions led promotion of fields such as space, nuclear, aviation and railroad during the Cold War, so as to be a nation independent of other nations.	Rapid growth of S&T accompanied rapid economic growth.	After the war, the government led the aggressive introduction of technology in industries such as textiles, shipbuilding, iron manufacturing, and electronics.
In the 1990s	• The Clinton Administration (inaugurated in 1992) promoted enhancement of high-tech competitiveness, subsidies for private companies, and support of small business R&D (e.g., SBIR). • In 1999, the concept of industry "clusters" as a source of innovation was created.	• In the early 90s, policy was changed to investment in basic research. • In the late 90s, innovation was promoted in light of the failure to commercialize R&D results.	• Under a tight budget due to reunification (1990), basic research was emphasized even as priority was given to the reconstruction of the former East Germany.	• Collaboration of companies, public research institutions and universities became common. • The need for prioritized science policies and creation of innovation and employment in small and mid-sized enterprises was recognized.	• A policy to build the nation based on science and technology and education was announced (1995).	• The "Long-term Vision for S&T Development Toward 2025" was established in 1999 to ensure world-class S&T competitiveness. • Expansion of R&D investment and development of S&T human resources was especially emphasized.
In the 2000s	• Debate about strengthening U.S. economic competitiveness increased in response to the rise of emerging countries and rapid progress in information and communication technology. • As a result, the Bush Administration (inaugurated in 2001) enacted the America COMPETES Act (2007) to improve basic research capabilities.	• It was decided to make a large increase in science research investment through the "Science and Innovation Investment Framework 2004-2014" (2004).	• Policies were implemented based on the "High-tech Strategy" (2006) to achieve future employment and quality of life improvements through innovation. • Investment in S&T has increased since Chancellor Merkel took office (2005).	• The Sarkozy Administration (2007) changed the direction of research from a focus on public research institutions to universities.	• The "Medium- to Long-term National S&T Development Plan" (2006) was announced as a 15-year program. • Independent innovation capabilities were enhanced through increases in total R&D budget and reinforcement of prioritized areas.	• The Framework Act on Science and Technology was enacted in 2001, and the 1st Basic Plan on S&T was established in 2002. • Investment in S&T was expanded drastically, especially in the IT field.
In the 2010s	• The Obama Administration (inaugurated 2009) followed the America COMPETES Act and promoted policies based on the "United States Innovation Strategy" (2011) aimed at investment in innovation infrastructure. • As the overall budget declined, the basic research budget was maintained at the status quo or increased.	• The "Innovation and Research Strategy for Growth" (2011) focused on the promotion of the R&D industry. • The "Growth Plan: Science and Innovation" (2014) set out a direction for the U.K. to be the most science- and business-friendly nation in the world.	• The "High-Tech Strategy 2020" (2010) was announced and cross-sectional "Future-oriented Projects" were planned. • "Industrie 4.0" was proposed (2011) as a future-oriented project to upgrade the manufacturing industry.	• The basic strategy "France Europe 2020" (2013) was established, focusing on social issues and technology transfer. • Major organizational changes were made to the government's S&T planning system.	• The "12th Five-year Plan for Economic and Social Development" (2011), which sets national guidelines, called for the creation of "strategic new industries" as future industry.	• With the change of president in 2013, there was extensive government reorganization, creating the new Ministry of Science, ICT and Future Planning. • In 2013, the 3rd Basic Plan on S&T was established, seeking advancement in five strategic areas ("High 5 Strategy").

Source) Prepared by the MLIT based on the "White Paper on Science and Technology 2015" by MEXT.

(3) Comprehensive Strategy on Science, Technology and Innovation

With the goal having been set to become the "world's most innovation-friendly country" and with the medium- to long-term direction pointed out by the Basic Plan, a Comprehensive Strategy on Science, Technology and Innovation has been established annually since FY2013 to identify especially crucial measures for that year in light of changes in the situation each year. Based on this comprehensive strategy, the CSTI serves as the headquarters for such things as the realization of an annual PDCA cycle directly connected to the budget, implementation of initiatives aimed at solving important issues, the creation of the "Strategic Innovation Promotion Program" (SIP), which targets everything from basic research to commercialization through cross-ministerial promotion, and creation of the "Impulsing Paradigm Change through Disruptive Technologies Program" (ImPACT), aims to create high-risk/high-impact innovation.

Given that FY2016 is the first year of the 5th Basic Plan, the Comprehensive Strategy on Science, Technology and Innovation 2016 (approved by the Cabinet on May 24, 2016) sets out measures to work on from FY2016 to FY2017 based on the 5th Basic Plan. Among those, the following five are given as items to be studied more thoroughly and levered into concrete action.

(i) Deepen and promote Society 5.0

Forcefully promote the concept of Society 5.0, which was first introduced in the 5th Basic Plan, from the first fiscal year and achieve both strong industrial competitiveness for Japan and resolution of social issues.

(ii) Strengthen human resources capability, including that of young people

(iii) Promote university reform and finance reform in an integrated manner

Strengthen the education of young people and university reform, which require immediate attention, and respond with flexibility and precision in an age of great change when it is difficult to make forecasts about the future.

(iv) Establish a virtuous-cycle system of human resources, knowledge, and capital through promotion of open innovation

Through regular coordination among industry, academia, and government as well as strengthened creation of venture companies, establish a system that creates a succession of Japan-originated innovations that lead the world.

(v) Strengthen the STI promotion function

Strengthen the STI promotion function, including reinforcing the headquarters function, and effectively and flexibly implement the policies and measures set out in the Basic Plan and this Comprehensive Strategy.

(4) Achievements and Challenges in 20 Years of Science and Technology Basic Plans

It has been 20 years since the 1st Basic Plan was established based on the Science and Technology Basic Law. The following table organizes the achievements and challenges in 20 years of Basic Plans as described in the 5th Basic Plan (Figure 1-2-2).

Figure 1-2-2 Achievements and Challenges in 20 Years of Basic Plans

Achievements	Challenges
• Enhancement of international competitiveness (steady development of the R&D environment, such as by increasing the numbers of researchers and published papers)	• "Fundamental strength" has declined (as demonstrated by a drop in the quality and quantity of papers by international standards, delays in establishing international research networks, and the difficulty of young researchers to demonstrate their abilities).
• Practical application of LED lighting • Development of human iPS cells for practical application to regenerative medicine	• Industry–government–academia partnerships have failed to develop fully. (Most industry–academia partnerships are small-scale and there is low mobility of human resources beyond organizations and sectors.)
• Japan produced the second-highest number of Nobel Prize winners in the natural sciences.	• Growth in government R&D investment has stalled. • Japan's international standing is on a declining trend.

Source) Prepared by the MLIT based on the Outline of the Fifth Science and Technology Basic Plan by the Cabinet Office

2 Competitive Environment Related to and Public Awareness of Innovation

According to the Japan Revitalization Strategy 2016, "The 'fourth industrial revolution,' which uses the technological breakthrough of IoT (Internet of things), big data, artificial intelligence and robot sensors, is the most important key to leading a future revolution in productivity." Below, we analyze Japan's strengths and weaknesses regarding innovation from this perspective.

(1) Global Innovation Ranking

Every year the Global Competitiveness Report published by the World Economic Forum (WEF) evaluates leading countries' competitiveness, which is a determinant of productivity, based on the Global Competitive Index[Note 11]. Japan used to be in fourth or fifth place until last year, but it slipped down to eighth place in the 2016-2017 report (Figure 1-2-3).

The Japan Revitalization Strategy 2016 (Short- to Mid-term Progress Schedule) states that "Japan will be in the top three in the World Economic Forum's global competitiveness ranking by 2020" as a KPI.

Note 11 GCI

Figure 1-2-3 Trend in Innovation Rankings Over Time

	WEF's annual Global Competitiveness Report						
Ranking	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1	U.S. (5.85)	Switzerland (5.77)	Switzerland (5.78)	Finland (5.79)	Finland (5.78)	Switzerland (5.76)	Switzerland (5.80)
2	Switzerland (5.60)	Sweden (5.76)	Finland (5.75)	Switzerland (5.70)	Switzerland (5.70)	Finland (5.73)	Israel (5.73)
3	Finland (5.56)	Finland (5.72)	Israel (5.57)	Israel (5.58)	Israel (5.56)	Israel (5.65)	Finland (5.68)
4	Japan (5.52)	Japan (5.59)	Sweden (5.56)	Germany (5.50)	Japan (5.54)	U.S. (5.58)	U.S. (5.64)
5	Sweden (5.45)	U.S. (5.57)	Japan (5.54)	Japan (5.49)	U.S. (5.49)	Japan (5.54)	Germany (5.58)
6	Israel (5.30)	Israel (5.53)	U.S. (5.50)	Sweden (5.43)	Germany (5.47)	Germany (5.51)	Sweden (5.49)
7	Taiwan (5.29)	Germany (5.39)	Germany (5.42)	U.S. (5.37)	Sweden (5.37)	Sweden (5.46)	Netherlands (5.44)
8	Germany (5.19)	Singapore (5.33)	Singapore (5.39)	Taiwan (5.25)	Netherlands (5.25)	Netherlands (5.37)	Japan (5.43)
9	Singapore (5.04)	Taiwan (5.27)	Netherlands (5.31)	Singapore (5.19)	Singapore (5.18)	Singapore (5.24)	Singapore (5.33)
10	Denmark (4.89)	Denmark (5.10)	U.K. (5.17)	Netherlands (5.16)	Taiwan (5.10)	Denmark (5.11)	Denmark (5.13)

(Note) Innovation rankings for each year in the WEF's "Global Competitiveness Report." Figures in parentheses denote the score.
Source) Prepared by the MLIT based on the "Analysis of the Current Innovation Rankings in the World Economic Forum's (WEF) Global Competitiveness Report" by the Cabinet Office

(2) Features of Japanese Innovation (Strengths)

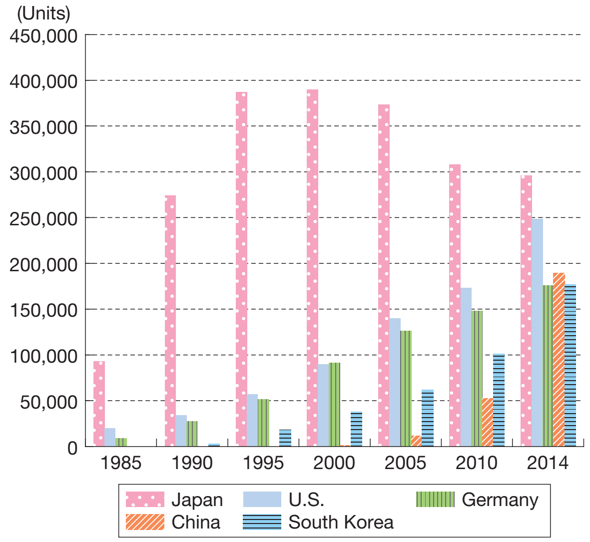
After World War II, Japan aimed to catch up with industry in the countries of Europe and America. Building on a foundation of technology from the countries that preceded it, Japan improved its production efficiency and developed manufacturing and applied technologies to create refined products, thereby achieving rapid growth. Given this history of development since the war, Japan has competitive power in the field of manufacturing. Moreover, the fact that Japan has world-class technical capabilities in the individual fields of the technologies in the fourth industrial revolution, such as IoT, big data, AI, and robot sensors, is a major strength.

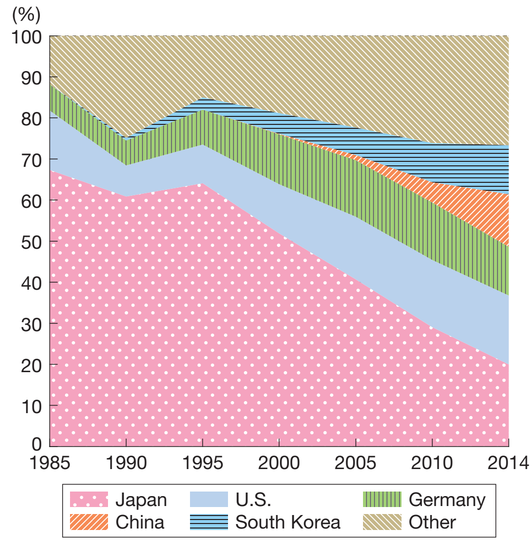
(Field of robotics)

As of 2012, Japan's shipment of industrial robots was valued at approximately 340 billion yen, accounting for around 50% of the global share[Note 12]. Furthermore, as of the end of 2014, Japan had about 300,000 industrial robots in operation (stock basis), accounting for approximately 20 percent of the global share and putting Japan in the top position (Figure 1-2-4).

Note 12 Subsection 1 "Japan as a robotics superpower," Section 1, Chapter 1, Part 1, "Japan's Robot Strategy" by the Japan Economic Revitalization Taskforce (February 2015)

Figure 1-2-4 Number and Share of Industrial Robots in Operation in the World



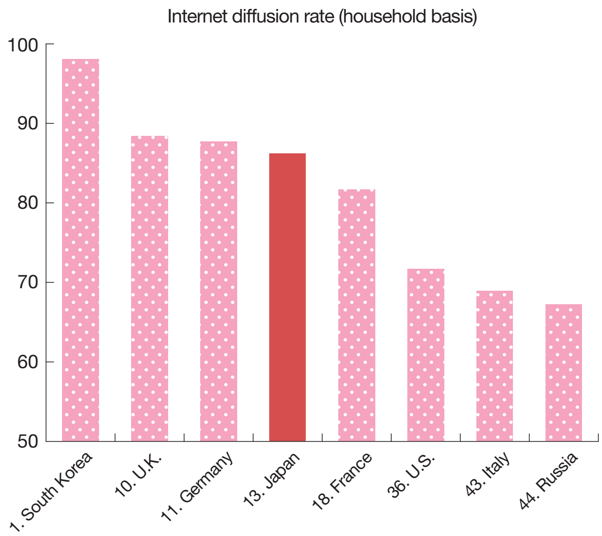


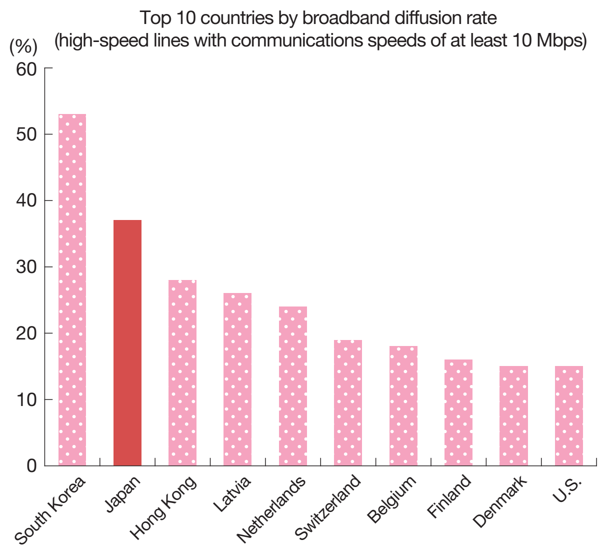
Source) Prepared by the MLIT based on material from the Japan Robot Association (source: "World Robotics 2015 Industrial Robots" by the International Federation of Robotics (IFR))

(Communications network infrastructure)

Japan's Internet and broadband diffusion rates are high even by global standards (Figure 1-2-5) and its optical communications technology, including the size of its transmission capacity, its large multicore fiber manufacturing and element technology, and its practical application of 100 Gbps signal processing lines, are at a world-class level[Note 13].

Figure 1-2-5 World-class Communications Infrastructure





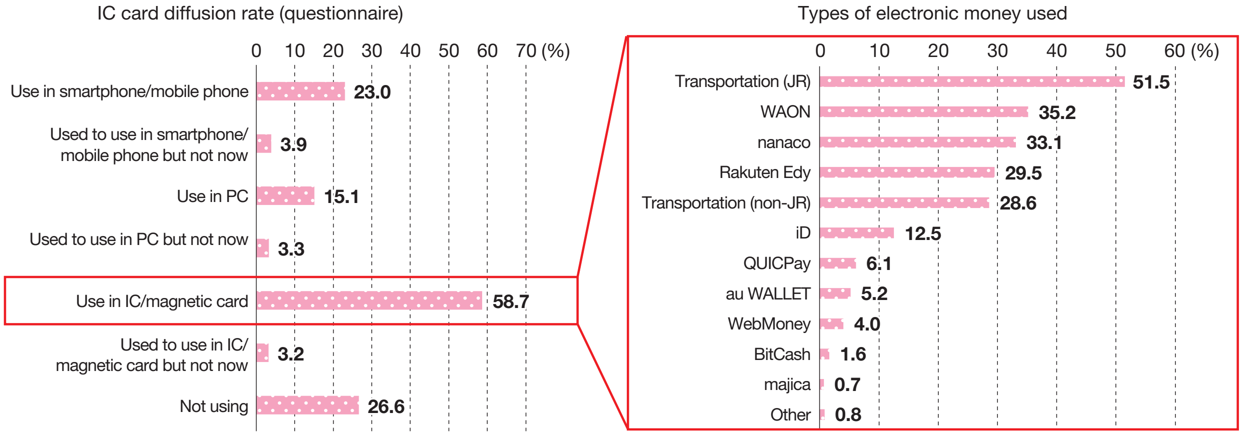
Source) Prepared by the MLIT based on material from the third meeting of the Industrial Structure Council's New Industrial Structure Task Force held on November 27, 2015 (source: ITU Web, Akamai Technologies' "State of the Internet" report (First Quarter, 2012))

Note 13 "The Ideal State of New Information and Communications Technology Strategy" interim report by the Information and Communications Council (July 28, 2015)

(Possession of big data (real data))

The diffusion rate of IC cards in Japan has broadened to 58.7%. Since transportation (JR) types of electronic money are most common and account for more than half of users, it is thought that there is a considerable amount of big data (real data) accumulated by individual IC cards (Figure 1-2-6).

Figure 1-2-6 Diffusion Rate of Electronic Money and Spread of Transportation E-Money



Source) Prepared by the MLIT based on material from the third meeting of the Industrial Structure Council's New Industrial Structure Task Force held on November 27, 2015 (source: questionnaire survey by NTT Communications Corporation)

(Supercomputers)

Supercomputers demonstrate their power in the analysis of big data. Japan's supercomputer 'K computer' has a computational performance that is among the best in the world, including first place in performance analyzing large and complex data[Note 14].

(3) Features of Japanese Innovation (Weaknesses)

Japan has high technical capabilities in the individual fields of the key technologies in the fourth industrial revolution. On the other hand, it lags behind the U.S. and other leading industrialized nations in using those technologies to quickly establish new business models and roll them out globally. Below, we examine the main factors for that in terms of the characteristics of human resources and companies.

(Human resources)

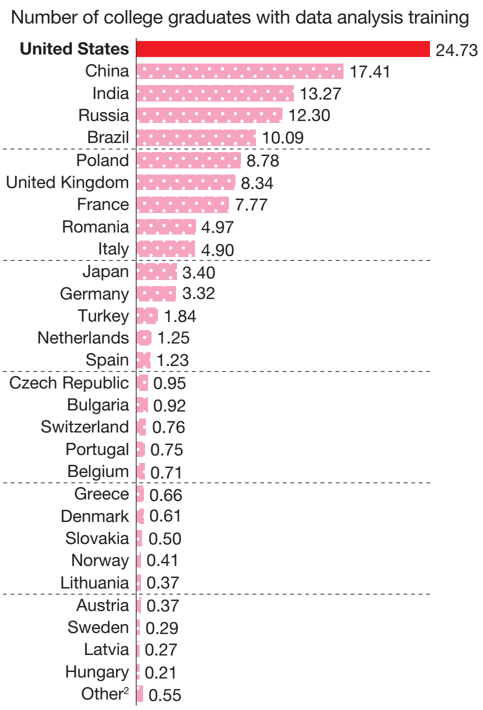
Given the context of progressing ICT, there are movements such as the creation of data-based industrial services and the rise of platforms in the U.S. and other leading industrialized nations[Note 15]. The need for human resources proficient in such things as the processing technology needed for data analysis, data visualization, and data analysis methods (i.e., data scientists) is forecast to increase worldwide in the future. But there is a shortage of such human resources. In 2008, Japan

Note 14 According to the Riken Advanced Institute for Computational Science and to Fujitsu Ltd., "The supercomputer 'K computer' took first place in the world in the HPCG benchmark, an international ranking of processing speed using the conjugate gradient method, which is used in actual industrial applications" (November 16, 2016). Also, according to an international collaborative research group consisting of Kyushu University, the Tokyo Institute of Technology, Riken, Spain's Barcelona Supercomputing Center, and Fujitsu Ltd., "The supercomputer 'K computer' took first place for the fourth time in a row (fifth time total) following June 2016, based on analysis results, in Graph 500, an international performance ranking for supercomputers related to big data processing (big graph analysis)" (November 18, 2016).

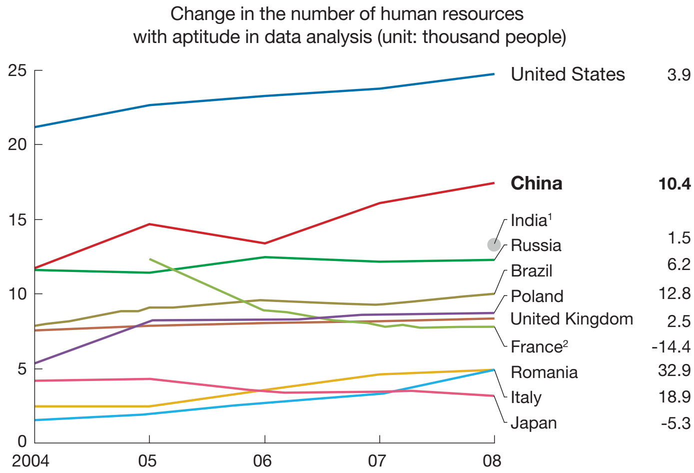
Note 15 According to the "White Paper on Science and Technology 2016" by the Ministry of Education, Culture, Sports, Science and Technology, there is movement to venture into other business domains and roll out business through new combinations of business domains, with the aim of meeting customer needs that were not fully understood and met before. With that development, the barriers between existing industries could become lower and those industries could be reorganized into new markets and industrial groupings originating with customer needs. The reference here is to the entities causing this kind of reform in industrial structures.

graduated 3,400 people with experience of advanced training in statistics and machine learning and who have aptitude in data analysis (Figure 1-2-7, left). Also, whereas the number of human resources with aptitude in data analysis was rising in other countries during the five years from 2004 to 2008, it was on a declining trend in Japan (Figure 1-2-7, right).

Figure 1-2-7 Development and Change in the Number of Human Resources with Data Analysis Skills



2 Other includes Finland, Estonia, Croatia, Slovenia, Iceland, Cyprus, Macedonia, and Malta.



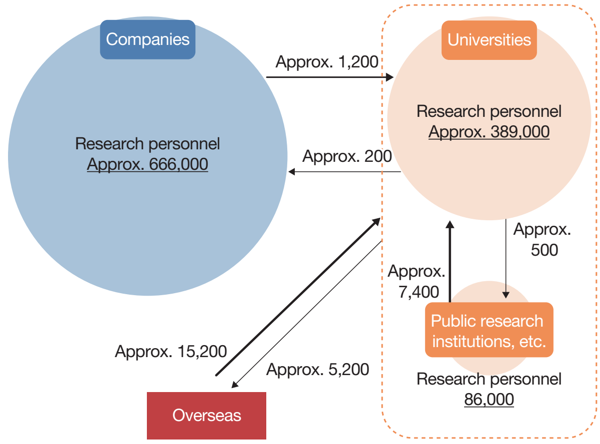
1 India ranked third in 2008 with 13,270 people with deep analytical skills but India does not have a time series for these data.
2 For France, the compound annual growth rate is for 2005 and 2008because of data availability.

Source) Prepared by the MLIT based on "Big data: The next frontier for innovation, competition, and productivity" by the McKinsey Global Institute

In order to maximize the potential for the creation of innovation in Japan, there is a need to encourage the active participation of diverse human resources, including women and foreigners, and to advance the integration of knowledge and the social implementation of research results in a global environment with mobility of human resources across barriers such as field, organization, sector, and national borders.

Looking at the movement of researchers between sectors in Japan, we see that movement is low overall and is especially low from universities to the corporate sector and from universities to public research institutions (Figure 1-2-8). Also, looking at the cross-border movement of human resources, we see that that percentage is low compared to other countries and that there is a high percentage of people who remain within Japan (Figure 1-2-9).

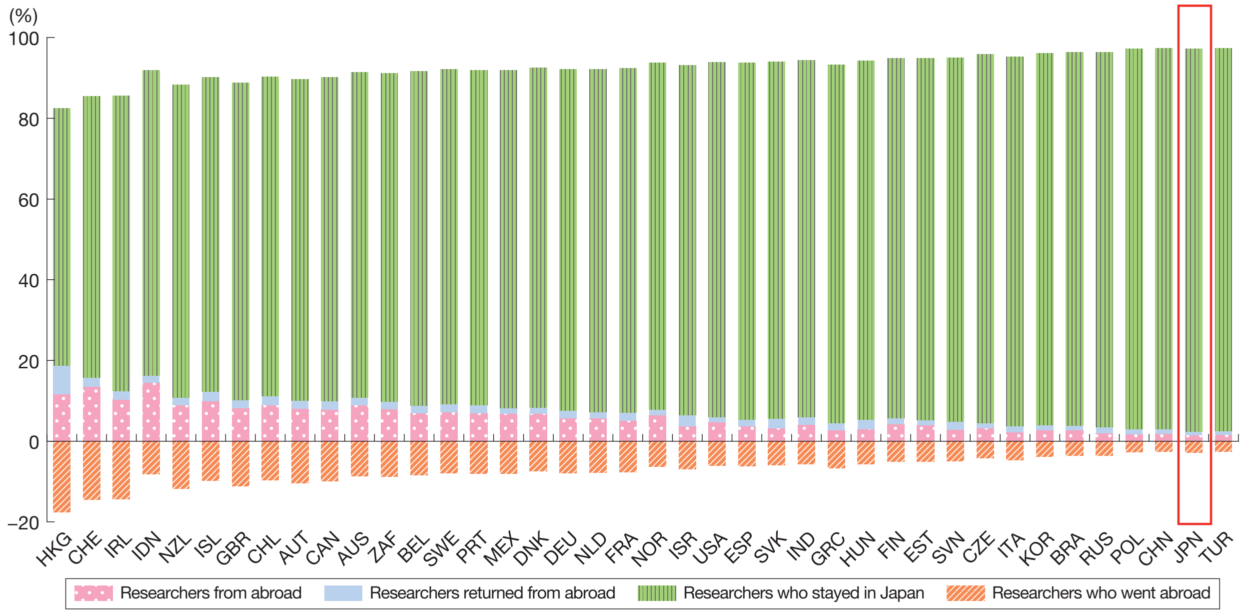
Figure 1-2-8 State of Mobility of Research Personnel in Japan (FY2013)



* For mobility between organizations within Japan, the number of researchers who joined the research personnel from outside the organization. "Overview of International R&D" by MEXT for acceptance from overseas into Japanese universities and independent administrative corporations as well as the number of dispatched researchers (medium- to long-term).

Source) "Interim Report (Reference Materials on Initiatives to Promote Innovation)" by the R&D and Innovation Working Group of the Subcommittee on Industrial Science and Technology Policy and Environment under the Industrial Structure Council (May 13, 2016)

Figure 1-2-9 International Mobility of Scientific Paper Authors by Country (2013)



Source) Prepared by the MLIT based on the OECD Science, Technology and Industry Scoreboard 2015

(Companies)

■ R&D investment stuck in an "in-house" mindset

While corporate R&D is carried out actively in Japan, it is lagging behind in freeing itself from an "in-house" mindset. R&D investment is not always connected to commercialization and corporate earnings. There is a need to establish an innovation system leading from business conceptualization through R&D to market acquisition/development (Figure 1-2-10).

Figure 1-2-10 R&D Investment Stuck in an "In-house" Mindset

<Percentage of outside collaboration on a project basis in R&D>
(Overall: N = 178, unit: %)

Development wholly in-house	62.2
Collaboration with group companies	8.3
Collaboration with other companies in same field in Japan (horizontal collaboration)	3.4
Collaboration with other companies in same value chain in Japan (vertical collaboration)	5.3
Collaboration with other companies in Japan (cross-industry collaboration)	4.2
Universities in Japan	7.8
Collaboration with public research institutions in Japan (e.g., former national research and development agencies)	3.1
Collaboration with venture companies in Japan	0.8
Collaboration with universities outside Japan	0.9
Collaboration with public research institutions outside Japan	0.2
Collaboration with foreign companies (excluding venture companies)	1.5
Collaboration with venture companies outside Japan	0.4
Commission from other companies, etc.	1.9

<Handling of technology and ideas that were not commercialized>
(Overall: N = 174, unit: %)

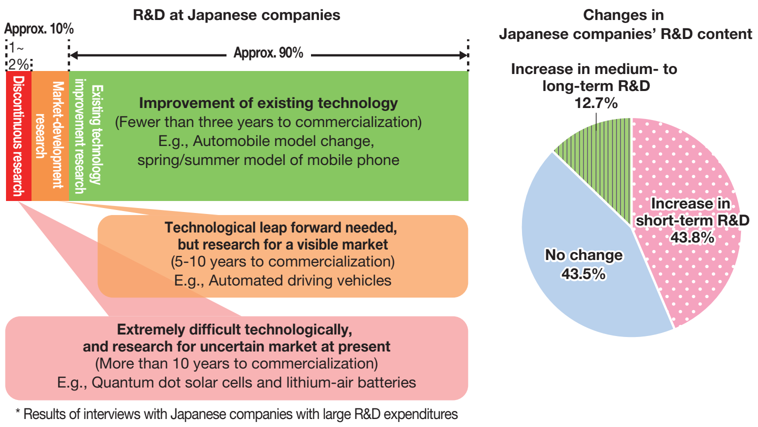
Implemented by a group company	11
Used by another company	5
Employees / Organizational spin-off	2
Continue considering behind the scenes	19
Allow to lapse	63

Source) Prepared by the MLIT based on "FY2015 Commissioned Industrial Economic Research Project (Study of Propensity for Corporate R&D Investment)" by METI

■ Short-termism

Due to the intensification of international competition, companies around the world are tending to divert much of their R&D expenditure into short-term research. In Japan as well, awareness of medium- to long-term R&D investment that takes more than three to five years until commercialization could be low as a trend in private sector R&D investment. There is a greater need for the national government to support medium- to long-term R&D (Figure 1-2-11).

Figure 1-2-11 Short-termism

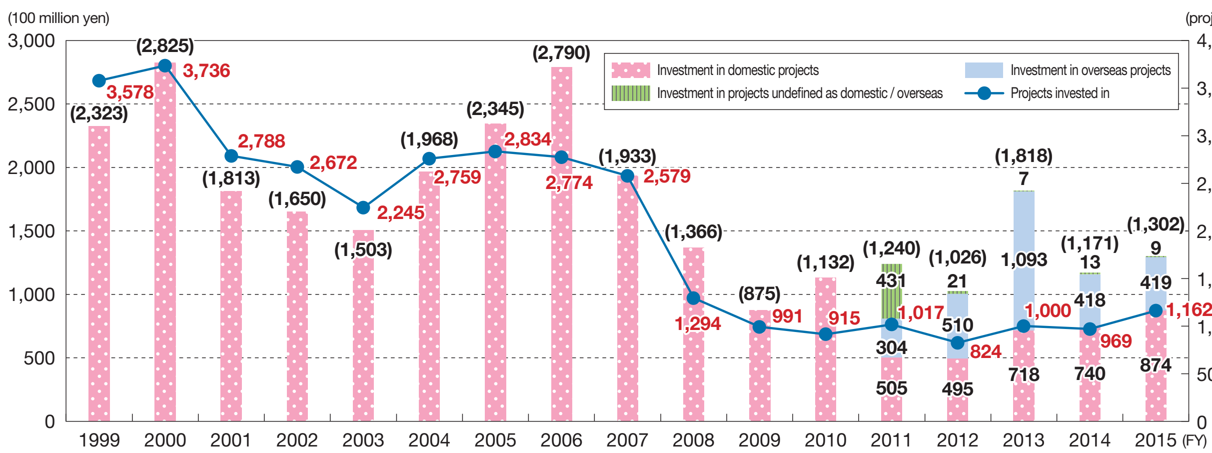


Source) Prepared by the MLIT based on "FY2010 Industrial Technology Survey (Corporate Questionnaire on Open Innovation)" by METI

(Creation of SMEs and venture companies)

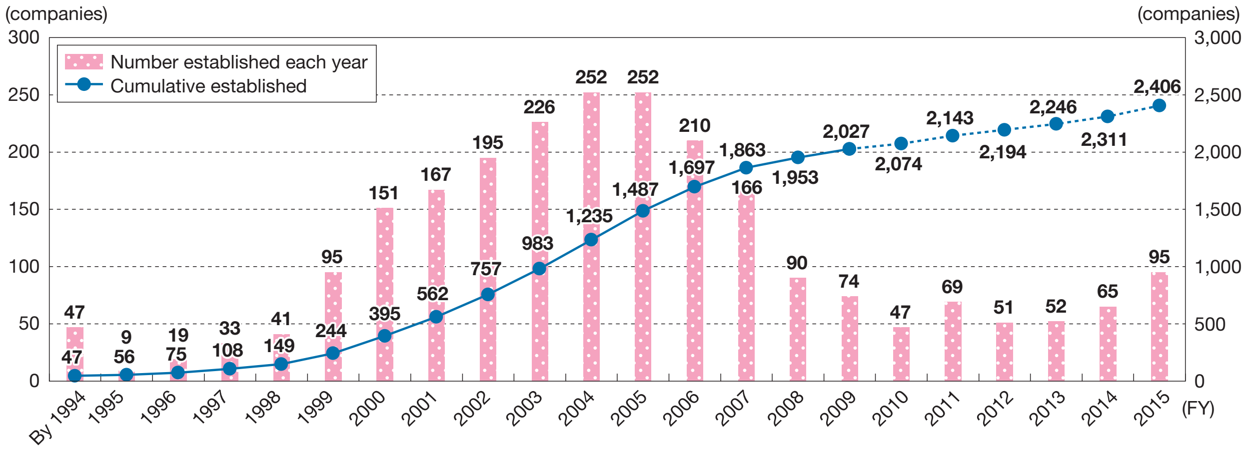
It is important to further encourage companies to take on the challenge of assuming risk to create new value and to develop an environment that fosters strings of diverse endeavors. Venture capital investment is increasing markedly more for overseas projects than for projects in Japan (Figure 1-2-12). Moreover, the number of venture company startups in Japan is not growing (Figure 1-2-13). This is a difficult situation for the creation of innovation by SMEs and venture companies.

Figure 1-2-12 Trend in Annual Investment by Japanese Venture Capitalists, etc.



(Note) Figures in parentheses denote the total investment and lending amount for domestic and overseas projects.
Source) Prepared by the MLIT based on the "VEC YEARBOOK 2016" by the Venture Enterprise Center

Figure 1-2-13 Venture Companies Established from Universities, etc.



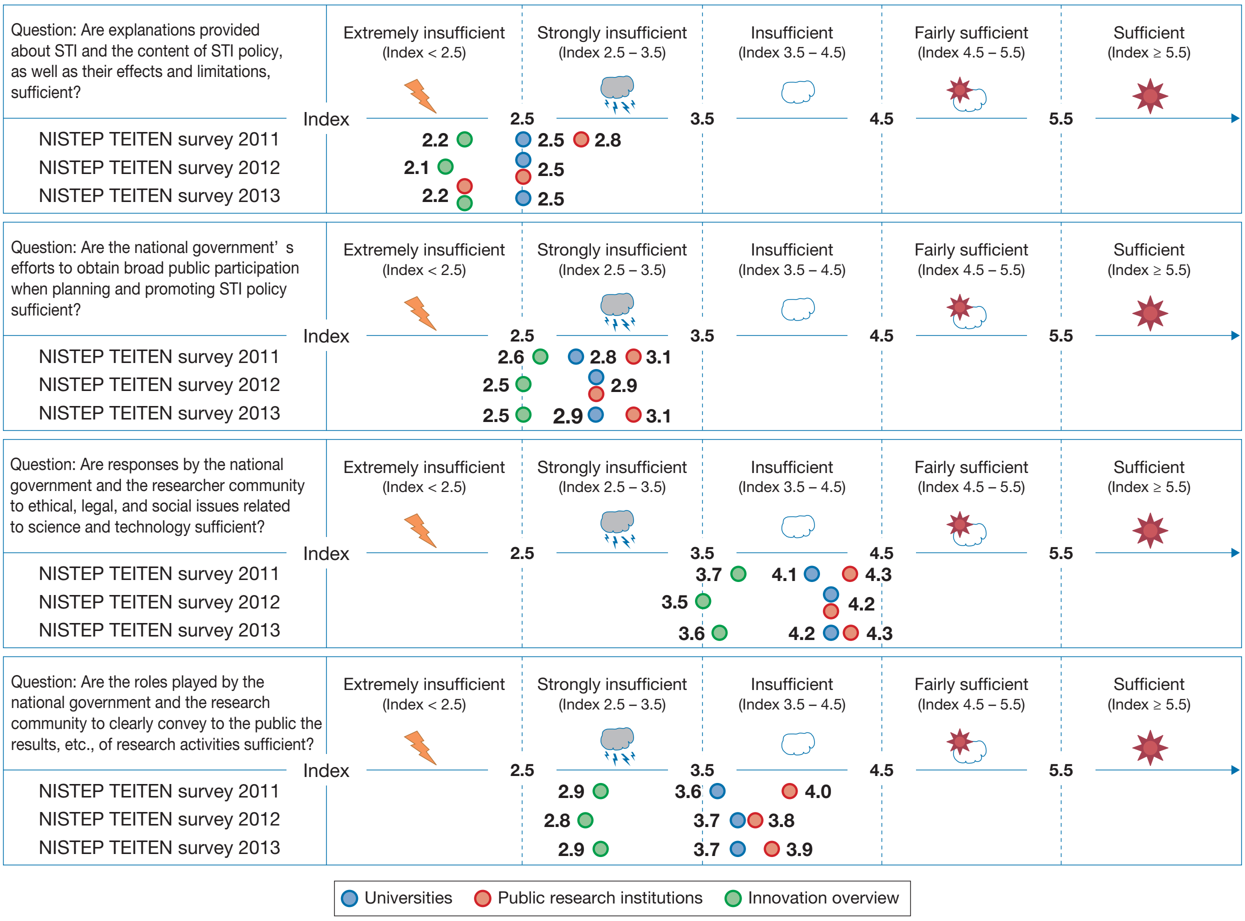
(Notes) 1 Here, "universities, etc." refers to public and private colleges / universities (including junior colleges), public and private colleges of technology, and inter-university research institutes (1,071 institutes in all).
2 Since performance up to FY2009 is based on surveys by the National Institute of Science and Technology Policy at MEXT, and performance from FY2010 is based on this survey, the cumulative establishment is shown as a dashed line.
3 The number of venture companies established from universities, etc., and their cumulative establishment up to FY2009 were aggregated based on the results of surveys by year of establishment conducted on "venture companies established from universities, etc., that are currently active and have a known location." Venture companies established from universities, etc., that were newly identified as having been established in a fiscal year before the fiscal year of the survey were added to the data for previous fiscal years. Data for FY2010 and later has been aggregated only for the number of venture companies established from universities, etc., for which there was a reply from the university, etc., that a venture company was established in the fiscal year of the survey.
4 The fiscal year of establishment is from April of that year until March of the following year. Companies for which the month of establishment is unknown were aggregated as if established in April or later.
5 The performance up to FY2009 included nine companies with unknown years of establishment, but they were removed from the totals.
Source) Prepared by the MLIT based on "Status of Industry-Academia Collaboration in Universities in FY2015" by MEXT

(Awareness of innovation)

In order to promote innovation going forward and realize social implementation, there is a need to deepen activities related to innovation in society and for diverse parties concerned to collaborate closely. We will therefore take an overview of awareness of innovation at such places as universities, public research institutes, and private companies.

First, we will look at the awareness of the national government's innovation policy. On a survey of researchers and experts in industry, academia, and government, the predominate result was "strongly insufficient" in response to the questions: "Are explanations provided about STI and the content of STI policy, as well as their effects and limitations, sufficient?" and "Are the national government's efforts to obtain broad public participation when planning and promoting STI policy sufficient?" (Figure 1-2-14).

Figure 1-2-14 Awareness of Social and STI Policies

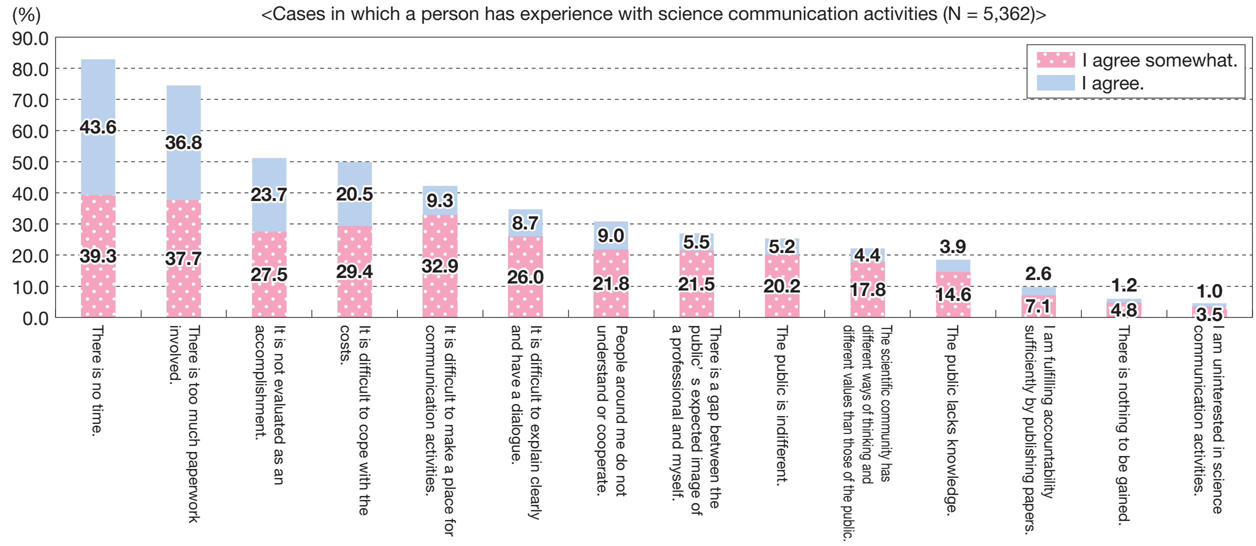


* "Universities" and "public research institutions" refer to the heads, faculty members, and researchers of universities / colleges and public research institutions. "Innovation overview" refers to industry and other experts and people acting as a bridge between R&D and innovation.
Source) Prepared by MEXT based on "Analytical Report for 2013 NISTEP Expert Survey on Japanese S&T and Innovation System" NISTEP REPORT NO. 157 (April 2014) by the National Institute of Science and Technology Policy (NISTEP)

Next, we look at the situation surrounding dialogue between researchers and the public. According to a survey of the actual condition and awareness of science communication activities by researchers[Note 16], many researchers cite such reasons as "There is no time," "There is too much paperwork involved," and "It is not evaluated as an accomplishment" as obstacles to scientific communication activities (Figure 1-2-15).

Note 16 Refers to activities with the aim of researchers (professionals) and non-researchers engaging in two-way communication of information and opinions about science and technology and social issues so as to share them as larger problems in society. Accordingly, the form of activities includes a broad range of activities from outreach to participation in policy-making, across all academic fields, including physical sciences, agriculture, engineering, medicine, dentistry, and pharmacology as well as the humanities and social sciences.

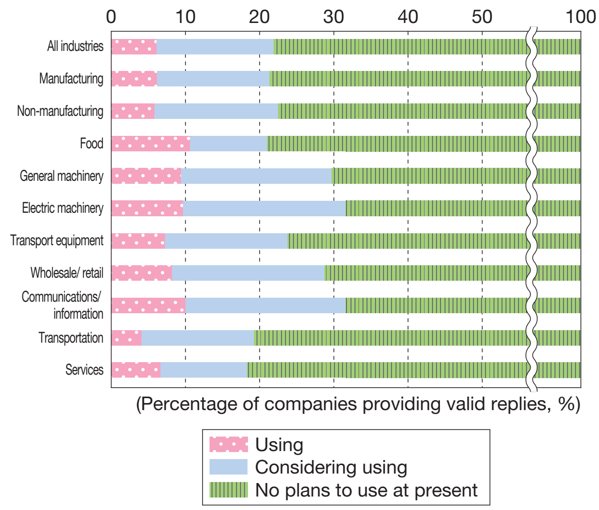
Figure 1-2-15 **Obstacles in Conducting Science Communication Activities**



Source) Prepared by the MLIT based on the "Report of a Questionnaire Survey on Science Communication Activities by Researchers" (July 2013) by the Center for Science Communication at the Japan Science and Technology Agency

Finally, we will look at corporate awareness. As we have seen thus far, the use of IoT, big data, and AI has gained attention globally. The application of IoT, big data, and AI at Japanese companies is low in all industries, at around 20-30 percent, combining the replies "Using" and "Considering use" (Figure 1-2-16).

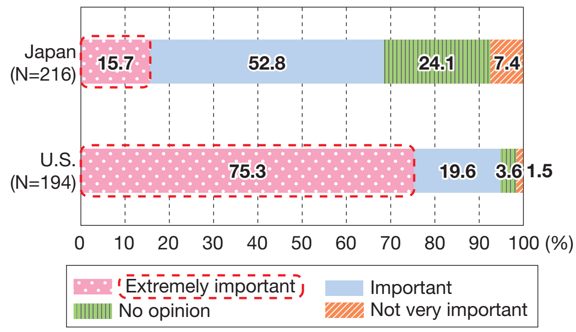
Figure 1-2-16 **Application of IoT/Big Data**



(Sources) The number of replies on the "2015 Poll of Corporate Activity" by the Development Bank of Japan were: 520 manufacturing companies with capital of at least 1 billion yen, 668 non-manufacturing companies, 38 food companies, 74 general machinery companies, 62 electric machinery companies, 55 transport equipment companies, 135 wholesale and retail companies, 89 communications and information companies, 144 transportation companies, and 60 service companies.
Source) Prepared by the MLIT based on "Trends in Capital Investment in Electric Machinery: Embarking on Growth Investment in Fields of Expertise" (September 2015) by the Development Bank of Japan

Furthermore, recognition of the importance of investing in information systems in Japanese companies is low compared to that in the United States, with 75.3% of American companies overall replying that it is "extremely important," whereas only 15.7% of Japanese companies made the same reply (Figure 1-2-17).

Figure 1-2-17 Importance of Information Systems Investment



Source) Prepared by the MLIT based on "Analysis of the Difference between Japanese and American Companies regarding Management using IT" (October 2013) by the Japan Electronics and Information Technology Industries Association (JEITA) and IDC Japan.

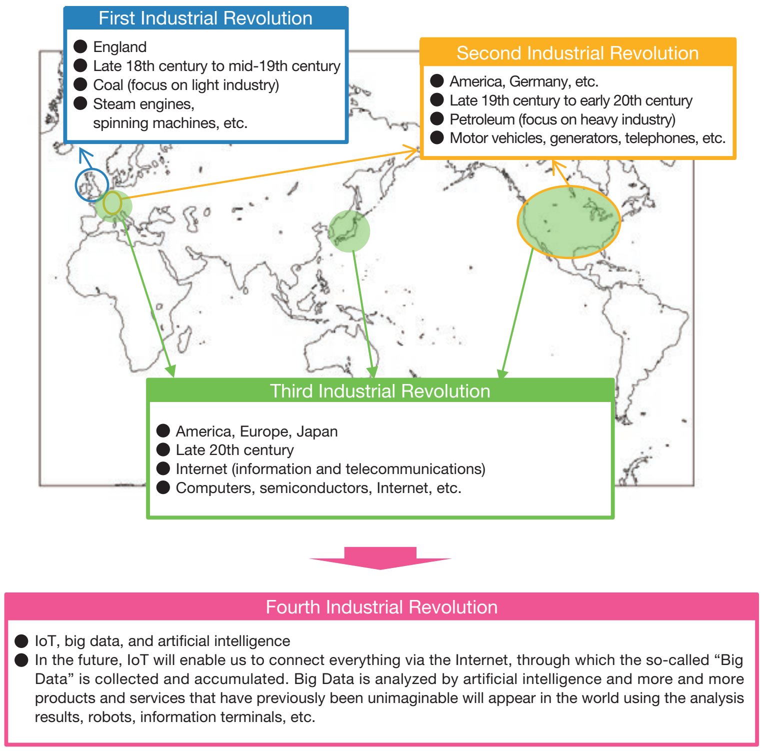
Section 3 History of Innovation

1 History of Diverse Innovation in the World

(1) History of the Industrial Revolution

Looking back at the history of the Industrial Revolution, we find that the first Industrial Revolution acquired coal energy as a power source for light industry. The second Industrial Revolution was then marked by innovation as the power source shifted from coal energy to petroleum energy, bringing development of heavy industry. In the third Industrial Revolution, computers became the focus and the information and telecommunications technology industry expanded. Notions of the coming fourth Industrial Revolution describe it as follows: In the future, IoT will enable us to connect everything via the Internet, through which the so-called "Big Data" is collected and accumulated. Big Data is analyzed by artificial intelligence and more and more products and services that have previously been unimaginable will appear in the world using the analysis results, robots, information terminals, etc.[Note 17] (Figure 1-3-1).

Figure 1-3-1 History of the Industrial Revolution



Source) MLIT

(2) History of the Development of Transportation and Innovation

Transportation is the movement of people and goods through a spatial dimension. Through exchanges of people and through trade in goods, people have enriched the knowledge, technology, and other components that make up culture and so have contributed to the prosperity of humankind. In this sense, people take transportation as more than just a means of

Note 17 "Japan Revitalization Strategy" 2016 movement. It can be described rather as a fount of vital energy that enables people to keep on living cultured and creative lives. When moving people and goods, today it is possible to choose from among various means apart from walking. These means of transportation may be taken for granted in the present, but the people of past times developed technology in the effort to increase efficiency and convenience, and they borrowed the technology developed in other sectors in order to create new means of transportation. They then improved the infrastructure to support those new means and developed related industries. These activities have had a tremendous influence on people's lives, as well as on societies and economies.

(Development and expansion of transportation in ancient times)

The wheel is said to have been produced by the Sumerians around 3,000 BCE, and carts drawn by horses, donkeys, oxen, and so on, were in use by around 2,500 BCE. During the era of the Roman Empire, "iron tires" appeared, made of wooden wheels with iron rings shrunk to fit around the rims. Stone-paved roads were also developed, giving rise to the saying that all roads lead to Rome. These were developed as roads upon which carriages could travel back and forth out of political, military, and administrative necessity, and these roads contributed to the formation of Europe's road network. In Japan, a system of five highways was built on main routes made up of highways characteristic of the Edo period (17th-19th century). The roads were rough and narrow, however, so the appearance of carriages was greatly delayed. The use of carriages did not become widespread until such vehicles were brought into Japan by foreigners in the mid-19th century.

There is also transportation by water, which began with people using objects they found around them for flotation, relying on those objects to hold them up. They then made rafts out of trees and so on, and turned rafts into boats and ships for their use. A ceramic flower vase excavated from a tomb in Egypt is said to date from around 4,000 BCE, and it is decorated with the image of a sailing boat. The Phoenicians, who were traders in the Mediterranean, built large sailing ships to use as trading ships, and would load their cargo on the Nile River in Egypt. Sailing ships basically navigate using their sails, showing a change from human power to wind power as their motive energy. The Phoenicians sailed from bases of their own along the eastern edge of the Mediterranean, in what is now Syria, Lebanon, and Israel, and ventured out toward northern Europe and the west coast of Africa. Sailing ships evolved, so that during the Age of Exploration, from the 15th century to the mid-17th century, the European nations used the ocean-going technology of large sailing ships and compasses to venture out across the globe. As to water transport in Japan, it had flourished since ancient times, given the natural conditions of this island country. The earliest written histories of Japan, the *Record of Ancient Matters* (Kojiki) and the *Chronicles of Japan* (Nihon Shoki) from the early 8th century, contain numerous accounts of boats and ships. Diplomatic relations with the Sui Dynasty of China (6th-7th centuries) were begun, for instance, as people traveled back and forth and trade was conducted with foreign countries, and the Edo Period brought the development of light cargo vessels that plied scheduled coastal routes. The emergence of scheduled routes navigated by shipping agents' vessels made it unnecessary for the merchants who were cargo owners to own and operate their own ships. This led to a separation between cargo owners and the shipping industry, which made it possible to have goods transported by payment of the fare.

The division of cargo owner and ship owner roles led to emergence of the idea of insurance. In the 14th century, merchants in Italy conceived an arrangement by which, when a voyage was a failure, financial traders would pay the cost of the cargo, and when a voyage was successful, the financial traders would be paid a fee. This is said to have developed into marine insurance. In order to apportion the risks of transport by sea, the Dutch created the East India Company in the early 17th century, and this is said to mark the creation of the world's first corporation. The Kameyama Company, founded by the prominent 19th-century figure Sakamoto Ryoma and others, has been called the origin of Japan's trading houses. Marine transportation and trade gave rise to enterprises operating by various different business methods.

(Motive energy and the appearance of transportation modes)

■ Land transportation

The first Industrial Revolution was accompanied by increases in the long distance movement of people and goods, and there was development of canals and toll roads. Production in factories was expanding, and there was growing demand for high volume, high speed, and regularly scheduled transportation. Canal transport operators tended to respond to the expanding demand by imposing higher fares, and users, including people in commerce and industry, were showing a growing dissatisfaction with conventional means of transportation. Attention turned to railroads as a new means of transportation, and in England, the Stockton and Darlington Railway (opened in 1825) linked a coal mining region, while the Liverpool and Manchester Railway (opened in 1830), linked the port city with the center of the cotton industry and machine industry. After that, railroad construction advanced in every region during the 1830s, in what is referred to as the first railroad boom, and railroads operated on trunk routes linking together major cities. During the 1840s, the construction of branch lines off the trunk routes brought the second railroad boom. The development of railroads advanced in every region. Fares on railroads were high at first, and use was limited to the upper classes. In 1844, however, the railroad laws made it mandatory for railroad companies to operate third class covered rail cars at low fares, and railroad use by the masses accelerated.

High speed and comfortable movement by railroad enlarged peoples' spheres of activity and simplified the movement of a variety of different commodities. The increasing speed of movement was accompanied by popularization of tourism and leisure activities, and as it became possible to transport massive numbers of spectators, horse racing, sports, and other such spectator events grew popular. With the appearance of railroads that charged low fares, the practice of laborers commuting to their workplaces grew widespread. There was also increasingly active movement of commodities, so that fresh food products produced in rural regions became available on city residents' dining tables. Fish and chips, sometimes called the food loved by all the English, became available for eating everywhere in England.

The first railroad in Japan was opened for service by the government between Shinbashi (in Tokyo) and Yokohama in 1872. Government funds gradually grew tighter because of the Satsuma Rebellion in 1877 and other events, and thereafter the construction of private railroads using private sector capital was promoted. The mid-1880s saw the start of a private railroad boom. With the arrival of the Showa Era (1926-1989), advancing urbanization was accompanied by the development of suburban electric rail networks, and Japan's first subway opened in Tokyo between Asakusa and Ueno in 1927. Under conditions of fiscal constraint, priority was given to the development of railroads, and the Tokaido Main Line, linking Shinbashi in Tokyo with Kobe, was opened in 1889.

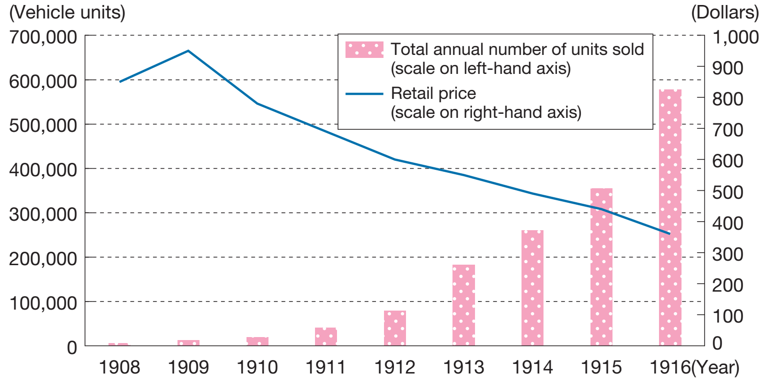
As to motor vehicles, a device using steam as its source of motive energy was created in 1769, and after that, vehicles using gasoline, electricity, and diesel fuel were invented in that order. Lenoir succeeded in practical application of the internal combustion engine (with thermal efficiency approximately three times that of steam engines) in France in 1860, and in 1862, an automobile using this engine was successfully test driven. The German Otto succeeded in developing a two-cycle engine in 1863 and a four-cycle engine in 1876. In 1886, Daimler (four-wheel vehicles) and Benz (three-wheel vehicle) in Germany completed a gasoline engine that is generally the same as present-day gasoline engines. As though that had opened the way, vehicles with gasoline engines that might be usable in today's cars entered production in France, England, the United States, and other countries. In the late 19th century, a variety of gasoline motor vehicles, electric motor vehicles, and steam motor vehicles were developed, but it was the 1901 discovery of Texas oil fields and other such factors that accelerated the spread of the gasoline engine.

Motor vehicles were initially objects for the nobility and privileged classes. In the United States, production was being carried out by approximately 500 motor vehicle manufacturers on a made-to-order production system. The United States is a vast land, however, and there was demand for motor vehicles as a means of transportation to replace horse-drawn carriages. The mass-produced Model T Ford automobile, a product of the pursuit of practicality, appeared in 1908. The vision of Henry Ford, founder of the Ford Motor Company, was to build a low-priced vehicle for the masses, and eventually to build vehicles not just for residents of urban areas but also for farmers. His objective therefore was to build sturdy, inexpensive, easy-to-handle vehicles, and the result was to introduce the conceptual approaches of parts processing and non-expert workers, cost reduction by mass production, simplification of driving, and so on. With a hint said to have come in 1913 from the conveyor belts in a meat processing plant, the world's first conveyor belt line manufacturing method was completed. In conventional motor vehicle production, the chassis (undercarriage) is fixed in place and numerous people gather around it to do the work. In the manufacturing method with a conveyor belt line, however, a moving assembly line is installed. The chassis is moved down the line to the people, who remain in their places. With the introduction of this method, the production time per vehicle went from 12.5 hours by fixed assembly to approximately 1.5 hours, shortening the time to one-eighth.

Due to mass production and sales of the inexpensive Model T Ford (Figure 1-3-2), motor vehicles penetrated the mass popular market. This made it possible for farmers to enjoy the same modern lifestyle as people living in the cities.

Motor vehicles were brought into Japan from overseas in 1898. The Yamaba steam-powered motor vehicle was completed in 1904, the first such vehicle to be made in Japan. In Europe, where carriages had been widely used, there were straight, stone-paved roads such as the Appian Way, and vehicles could run on those roads that existed from the past. In Japan, road surfacing consisted of no more than some stone paving on steep roads for people and horses, and some gravel-surfaced roads for the use of carriages. At the same time that the Road Act was instituted in 1919, plans for trunk roads centered on major cities such as Tokyo and Osaka were formulated, and full-scale construction of roads with asphalt surfacing was begun.

Figure 1-3-2 Number of Model T Ford Units Sold and Changes in Prices (1908-1916)



Source) Prepared by the MLIT from Yoshiji Suzuki's "Toward Inflexibility of Mass Production System, 1908-1972: The Historical Process in the American Automobile Industry" in Keizaigaku Kenkyu (Economic Studies)

■ Marine transportation

As to marine transportation, the creation of a steamboat by Fulton in the United States in 1807 was followed by increases in transportation efficiency that led to sailing ships being replaced by steamships during the last half of the 19th century. During the same period that saw widespread adoption of steamships, there was also a transition to ironclad ships and then to steel ships. Changes in motive power, such as the introduction of turbines and diesel engines, were accompanied by increases in ship speeds around the beginning of the 20th century.

In Japan, steamships surpassed Japanese-style ships in the mid-1880s. Networks of coastal shipping routes were formed around the routes serviced regularly by steamships. At the start of the 1910s, a network of railroad trunk routes had been formed that included the Japan Sea coast. The process of shifting transport functions from marine transport to railroads converged in the formation of a comprehensive domestic transportation network that combined the coastal shipping network with the railroad network.

■ Air transportation

In 1903, the Wright brothers became the first in the world to successfully engage in manned powered flight by means of an airplane. Scheduled airlines were established after the First World War. A man in Japan is also said to have discovered the principle of flight by observing how crows glide. There is a model of his "Jewel Beetle Flying Machine" on exhibit at the Royal Aeronautical Society in England, with an explanation that Ninomiya Chuhachi had discovered the principles of the airplane even before the Wright brothers. A military airfield was established at Tokorozawa in Saitama Prefecture in 1911, and the first airport in the country was built there. Tokyo Airfield (later Haneda Airport) opened in 1931 as an airport operated by the government exclusively for civil aviation, and Osaka Itami Airfield was completed in 1939.

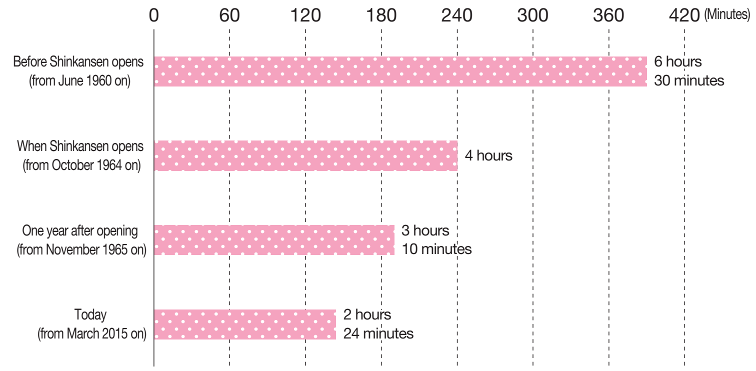
(Evolution of traffic and transportation)

■ Land transportation

The development of expressways and roads exclusively for motor vehicles progressed in the United States, where motorization was advanced, and in other locations worldwide. During the Second World War, the concept of a national people's car was proclaimed by Hitler in Germany, where the Autobahn was also built as a national government policy. The Volkswagen made its appearance in 1938. In the United States, a motor vehicle civilization developed at a rapid rate, partly because the American mainland had not become a battlefield. General Motors, Ford, and Chrysler took the lead in this movement. Toll expressways were built around the 1940s as a way of resolving congestion.

In Japan, a period of high economic growth began. In 1964, the Shinkansen made its appearance as a means of resolving the shortage of transportation capacity between Tokyo and Osaka. The bullet train running on this line made it possible for people to take a business trip between these cities and return the same day. The number of bullet train users grew, so that when the Osaka Expo was held in 1970, for example, it attracted 64 million visitors, of which 10 million used the Shinkansen. Movement from the Kanto Region to the Kansai Region and other such domestic travel became an increasingly familiar possibility for people (Figure 1-3-3). Europe and America had come to view railroads as antiquated technology, but due to the success of the Shinkansen, they were moved to reevaluate rail as a system of high speed intercity transportation. The development of high speed railroads therefore advanced in countries around the world.

Figure 1-3-3 Changes in Shortest Travel Time by Rail Between Tokyo and Osaka



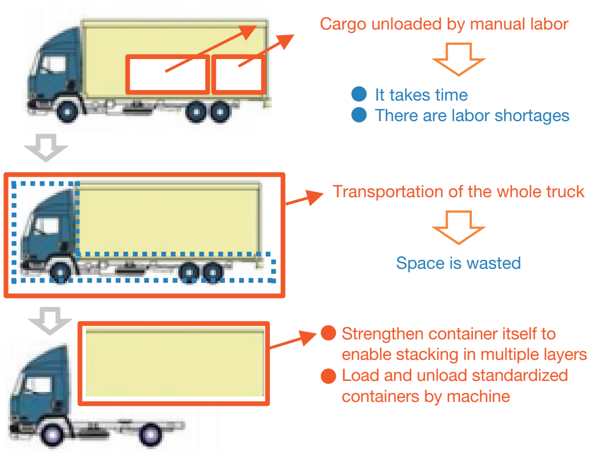
Source) Prepared by the MLIT from Nobuyuki Sato's Shinkansen History: Political and Business Dynamism (2015) and "Shinkansen Perfect History," from the JR Central website

On the roads, networks of expressways were also developed, and electronic toll collection (ETC) was adopted. The ETC system that entered general use in March 2001 involves insertion of an ETC card in a vehicle's on-board ETC unit, which communicates by radio with roadside antennas installed at toll plazas on the toll road so that the vehicle can pay the toll and pass through without stopping. The ETC system has realized smooth toll payment in this way, and in 2015, the ETC 2.0[Note 18] system began providing new driving support services in addition to toll payment, such as congestion avoidance support and safe driving support. At present, measures are being promoted to collect data on vehicle speed, routes, travel time, and so on using ETC 2.0, and to utilize this diverse and detailed body of big data for smart tolls that reduce congestion and accidents and provide highly productive smart logistics management and other such intelligent road use.

■ Marine transportation

In the area of transportation by sea, the rapid economic growth Japan experienced after the Second World War brought issues of increased freight volumes together with shortages of longshoremen. Delays in cargo handling due to manpower shortages also had repercussions on the efficiency of land transportation modes. Malcolm McLean, an American who ran a land transportation company, had originally been a truck driver, so he had the idea that using common transport units across different modes of transportation would be a key to rationalizing logistics. He bought a used freighter and experimented with loading entire truck trailers on board. In order to improve loading efficiency, however, McLean separated the driver's cab and vehicle portions from the trailer, and separated the trailer into the chassis and container portions, and developed a cell guide system that would hold the container portion in place on board the ship (Figure 1-3-4).

Figure 1-3-4 Conceptual Images of Changes in Container Transportation

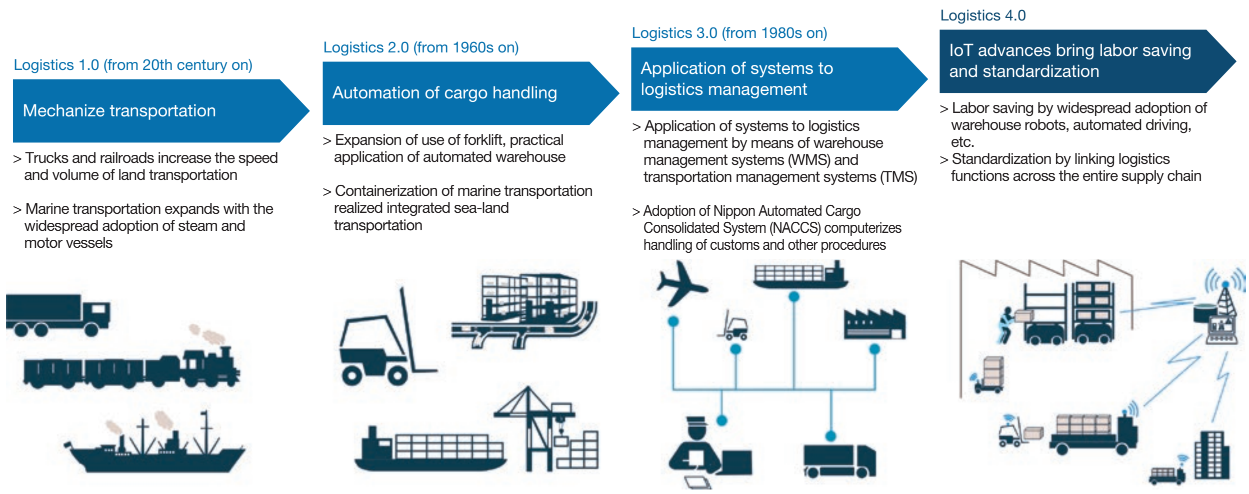


Source) MLIT

Note 18 ETC 2.0 provides driving support services (congestion avoidance, safe driving support) by means of the world's first road-vehicle collaboration system capable of high speed, high volume, bidirectional communication between vehicle on-board units and communication spots consisting of roadside antennas. When vehicles equipped with ETC 2.0 travel through toll plazas using ETC radio communication, they receive toll discounts on toll road sections near major urban areas. Where high volume, high frequency discounts occur, the road is treated as a road subject to discount (ordinary toll road).

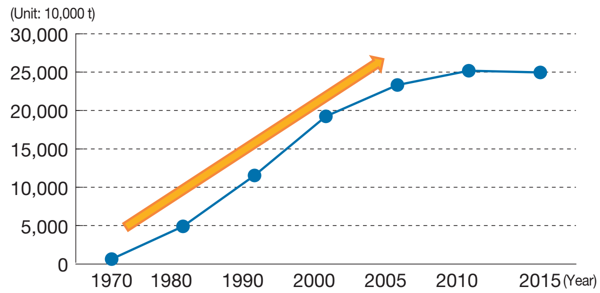
After success was achieved in integrated sea-land transportation in 1957, international standardization was achieved in 1961, and port and harbor development was carried forward in every country during the 1960s (Figure 1-3-5). In 1967, Japan's first container ship entered service. The strength of the containers themselves was increased after that so that they could be stacked in multiple layers, and this also contributed to progressive containerization around the world during the 1970s. The volume of trade by container increased. At present, approximately 90% or more of foreign trade by scheduled ship transportation is said to be containerized. Containers have been growing larger in recent years, with the introduction of 45 foot containers and so on. This kind of innovation related to containers can be considered to have contributed greatly to the high volume transportation society that is following the Third Industrial Revolution (Figure 1-3-6).

Figure 1-3-5 Changes in Logistics Innovation



Source) Roland Berger Ltd.

Figure 1-3-6 Changes in Import/Export Container Cargo Volume at Japanese Ports



Source) Prepared by the MLIT from "Port and Harbor Statistics (Annual Report)"

■ Air transportation

Aircraft made a nearly complete shift to jet engines at the end of the 1950s. In the case of passenger aircraft, this shift began in the 1950s and extended throughout air transportation as a whole during the 1960s. In Japan, the first scheduled domestic air service since the end of the Second World War started in 1951. The number of passengers increased significantly in conjunction with the liberalization of overseas travel in 1964, during the period of high economic growth, and the jumbo jet made its appearance during the 1970s. Access to the airport was also improved in various ways in 1964, the year of the Tokyo Olympics. Tokyo Metropolitan Expressway Route 1 to Haneda was opened as far as the Airport West Exit, for example, and the Tokyo Monorail opened from Hamamatsu-cho to Haneda (now Tenkubashi). Low-cost carriers (LCC) made their appearance in 2012, and more recently, efforts are being made for smart use of air transportation. The number of arrival and departure slots at airports has been expanded, for example, and research is being pursued in new materials that can support lighter air frames, greater durability, and so on. Contributions from Japan's technical capabilities are anticipated in such areas.

The development of aviation networks has brought popularization of travel by airplane. This is increasing exchanges between Japan and other countries, through business travel, tourism, and other such contact, and this is having a major influence on Japanese people's lives.

Column Ensuring Innovation and Safety

The automobile was invented, and as power performance increased with productivity and efficiency due to improving automobile manufacturing, various auto-related infrastructures were put into place. Many people acquired cars and began using them freely, and this can be called one of the modern innovations in land-based transportation. In Japan, the use of automobiles has increased from year to year, and as of 2016, Japanese people owned a combined total of over eighty million cars.

On the other hand, the number of deaths in traffic accidents has increased along with the increase in the number of vehicles. There was even an era known as the "traffic war," in which, for example, over ten thousand people died in traffic accidents in 1959. In recent years, however, continued efforts by concerned parties, including improvements in automobile safety performance, safety features in the infrastructure, and non-structural measures, such as beefing up driver safety education, have yielded results. By 2016, traffic deaths had fallen below four thousand per year.

Another example is the way in which various products and services have come to be distributed over the Internet. People accept the convenience, but currently, absolute levels of security cannot be guaranteed on the Internet, and as threats increase day to day, security measures are rapidly improving and evolving.

Looking back at history, we can see that there have been many cases in which it is difficult to guarantee absolute safety while in the process of implementing innovations in society. Society is currently weighing the convenience and dangers of these kinds of innovations, and making choices about whether to accept them.

It is anticipated that all sorts of innovations will be created throughout the world in the future, but it should be said that the people involved with them will need to make continual efforts to accept advantages to the greatest possible extent and minimize disadvantages so that society can develop greater affluence.

(3) Recent Diversity of Innovation in the World

■ Smartphones

Smartphones have expanded the functionality of mobile phones from the conventional telephone, e-mail, and so on, and also enable the collection of various kinds of information by browsing websites intended for use on personal computers. Users are now able to freely select and download for themselves a wide variety of applications (apps) from sites (markets) on the Internet. This makes it possible for users to customize their own data terminals so that they can use the terminals more conveniently and in ways suiting their own needs. In 2007, Apple put its iPhone on sale as the world's first touch panel mobile phone, greatly advancing the spread of smartphones. These phones came on the market In Japan in 2008, and the App Store also put in place a market for the sale of apps. By the end of 2015, the smartphone penetration rate had reached approximately 72%, and that rate has been rising every year (Figure 1-3-7).

In 2016, Apple had captured an approximately 80% share of global smartphone profits[Note 19] and the company built networks of services using its iPod, iPhone, iPad, and other such products. In the case of the iPhone, in particular, Apple created a new platform by introducing its updating system and publicly disclosing its app development arrangements. Apple develops its equipment and operating system in-house, keeping them closed[Note 20]. However, it has made its app development specifications open, taking an open innovation strategy that allows third parties to take part in content development.

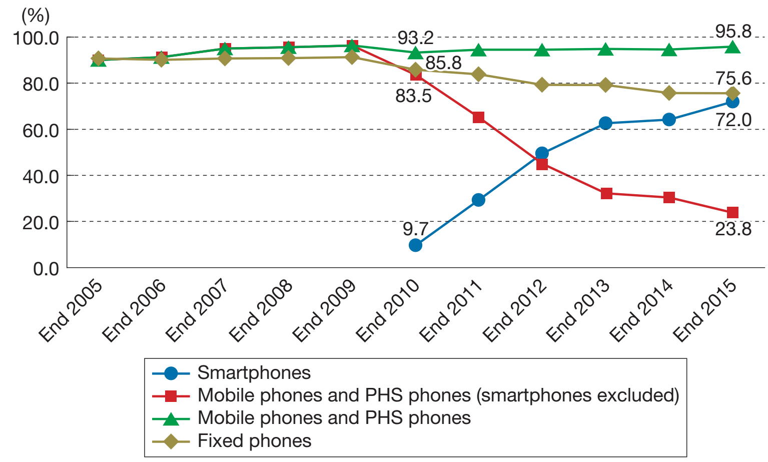
Note 19 From Strategy Analytics.

Note 20 Apple is slated to start operation at its first development center outside the United States when it opens the Tsunashima Technical Development Center (TDC), situated on the site of a former Panasonic plant located between Tsunashima Station and Hiyoshi Station.

Apple has made a software development kit publicly available for app developers, it has distributed programs and documentation required to develop apps, and it has set up a clearly defined distribution of revenue for app developers who have passed review. This has broadened the base of support for app developers so that apps are now also being developed by individual programmers, university students, and so on. Apple also takes steps in-house to create an organization that can more readily produce innovative products and services. When the company is commercializing a new product, for example, it puts together teams that are separate from the existing organization so that commercialization can proceeded while incorporating ideas from designers, engineers, and others involved.

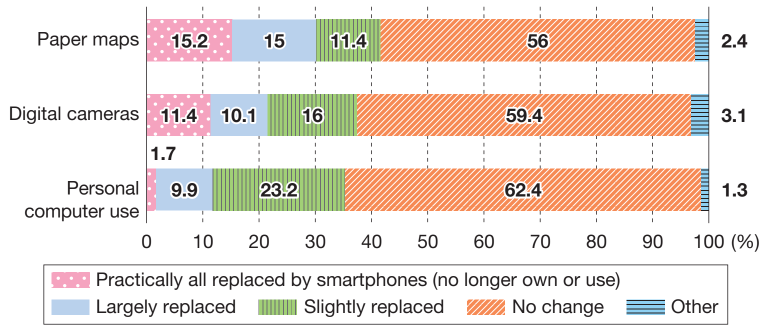
As described above, it is possible to add various different functions to smartphones by using apps. The Ministry of Internal Affairs and Communications report on "Contracting Survey Research Relating to the Impact of ICT Evolution on Society" (March 2014) describes the impact on the frequency of utilization of other services using other terminals after the purchase of smartphones in Japan. For instance, paper maps were 41.6% replaced, digital cameras were 37.5% replaced, personal computers were 34.8% replaced, and so on[Note 21] (Figure 1-3-8). Also, practically all university students think that personal computer skills are necessary, but some 70% of students have no confidence in their personal computer skills, while a private sector study shows that some newly hired employees are convinced that the cursor on a screen is not moved with a mouse but by touching the screen[Note 22]. The widespread adoption of smartphones thus has an impact on the use of existing services and is bringing about major changes in the lives of people in Japan.

Figure 1-3-7 Status of Penetration of Information and Telecommunications Equipment (Households)



Source) Prepared by the MLIT from the "2015 White Paper on Information and Communications in Japan"

Figure 1-3-8 Impact on Frequency of Utilization of Services on Other Terminals after Purchase of Smartphones (Domestic)



Source) Prepared by the MLIT from the Ministry of Internal Affairs and Communications' "Contracting Survey Research Relating to the Impact of ICT Evolution on Society" (March 2014)

Note 21 This is the total of "Practically all replaced by smartphones" and "Largely replaced" and "Slightly replaced" responses.

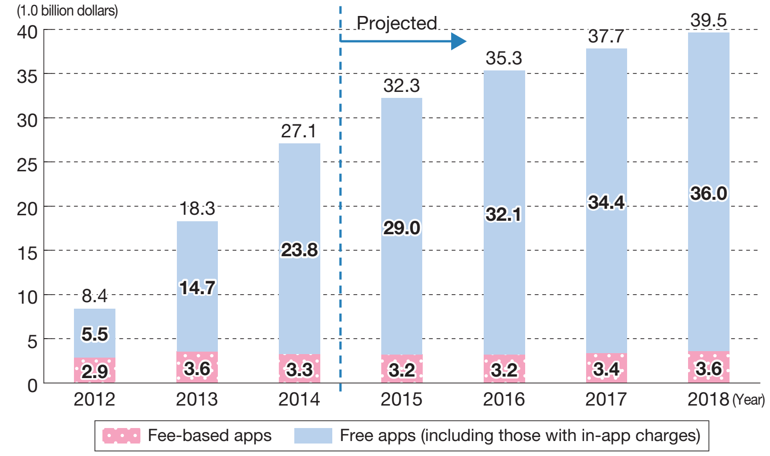
Note 22 From NEC Personal Computers, Ltd., "Questionnaire Survey of University Students (1st to 3rd Year Students), People with Job-Seeking Experience (4th Year University Students), and Personnel Hiring Managers Regarding Personal Computers."

An additional point is that the widespread adoption of smartphones has contributed to the creation and growth of smartphone-related industries. The market for the app industry was approximately 8.4 billion dollars in 2012, and this is expected to grow to approximately 35.3 billion dollars in 2016 (Figure 1-3-9). Super Mario Run and Pokémon Go are smartphone games that emerged from beginnings in Japanese games, and in 2016, these had risen to place among the top 10 downloads at app stores worldwide. They had become globally popular services. Games such as these are displaying an expanded range of use in attracting tourism and other such community development measures, sales promotions for the retail and restaurant business, and so on.

There are also other examples of services largely using smartphones that have expanded in recent years. In car sharing, there are studies showing that services that had fewer than 2,000 members in 2006 had grown to approximately 840,000 members in 2016[Note 23], and that when using these services, approximately 80% of people searched for and reserved cars using smartphones[Note 24]. This suggests that the widespread adoption of smartphones has contributed significantly to expansion of car-sharing services (Figure 1-3-10).

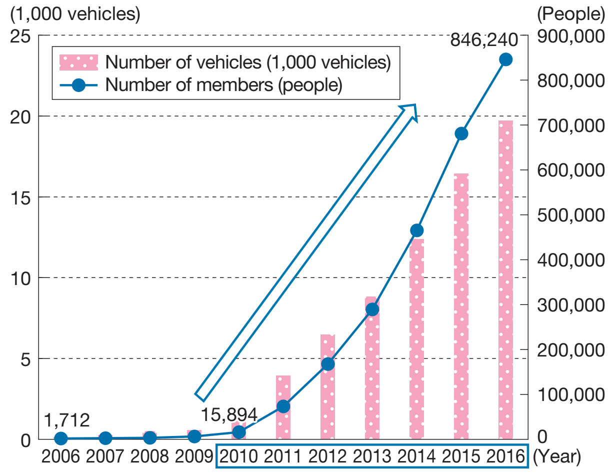
As this shows, the widespread adoption of smartphones is bringing about great changes in the lives of the Japanese people, as well as having a major impact on other industries, such as the creation of new industries. Japan's society and economy are experiencing major changes.

Figure 1-3-9 World Mobile App Market Scale Changes and Projections (by Type of Billing)



Source) Prepared by the MLIT from IHS Technology

Figure 1-3-10 Changes in Number of Vehicles and Number of Members of Car-sharing Services in Japan



Source) Prepared by the MLIT from information on the Foundation for Promoting Personal Mobility and Ecological Transportation website

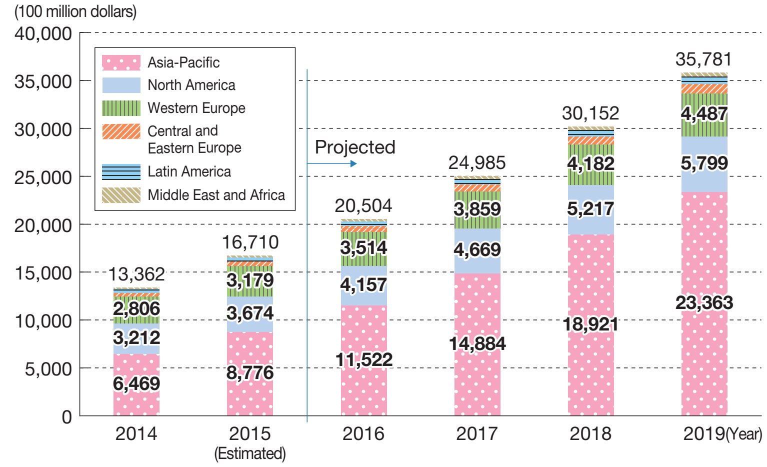
Note 23 From the website of the Foundation for Promoting Personal Mobility and Ecological Transportation.

Note 24 According to a questionnaire survey of members conducted by the Careco Car-sharing Club in 2015, smartphone apps account for the largest share at 48.7%, followed by smartphone sites at 29.7%, showing that approximately 80% of the total use car sharing by means of smartphones.

■ Electronic commerce

Due to the expanding use of the Internet, the electronic commerce market reached approximately 1.7 trillion dollars in 2015, and is projected to expand to approximately double that size, or 3.5 trillion dollars, by 2019 (Figure 1-3-11). The market has made it possible not only to purchase goods, but also to purchase and download books, music, movies, and other such content to one's own terminal. The Internet is exerting a major influence on people's buying behavior.

Figure 1-3-11 Electronic Commerce Market Scale Changes and Projections



Source) Prepared by the MLIT from the Ministry of Internal Affairs and Communications' "Study Report on a Structural Analysis of the ICT Industry in the IoT Era and Verification of ICT's Multifaceted Contributions to Economic Growth" (2016)

Amazon has provided various services, such as a personalization function that infers customer inclinations from past purchase history and other such information, customer reviews that allow people to freely post and view opinions and impressions of goods on the Amazon site, a recommendation function that displays recommended goods, and so on. Amazon uses technology it develops in-house for these kinds of website functions and its supply chain. Technology in the form of a new algorithm was developed for the recommendation function, for example, and according to a 2011 analysis by McKinsey & Company, 35% of Amazon's sales can be attributed to recommended goods. The development of this algorithm has contributed greatly to sales.

The core business of Amazon was book sales, and the decision to follow the strategy of computerizing that business was made in the context of Apple's rising share of the digital music market. The Kindle[Note 25] could have been termed a product that would destroy the company's existing book business, but in addition to offering large numbers of books, the company built a network that users could access at no charge and made it easy to download books.

There is also the point that Amazon has unlimited sales space by comparison with brick-and-mortar stores. This means it can make more types of merchandise available and follow a strategy of not running out of inventory (long-tail strategy). When users view merchandise on the site, Amazon also checks whether it is in stock or not using an indicator called the in-stock ratio. It uses these systems to prevent customer opportunity loss.

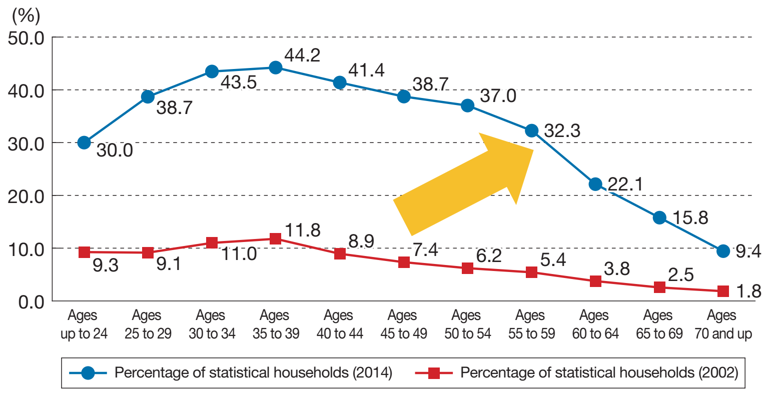
In the supply chain area, Amazon bought Kiva Systems LLC (now Amazon Robotics LLC), the robot manufacturer that realizes the automation of logistics, and introduced self-propelled robots to its distribution centers. In Japan as well, Amazon has started operation of a robot inventory management system (Amazon Robotics) that it introduced in its new logistics base, the Amazon Kawasaki Fulfillment Center (FC) in Kawasaki City, Kanagawa Prefecture. Introduced first in the United States and Europe, this system has robots that can move around in the warehouse and carry merchandise, and the idea is that it can help to augment worker shortages in warehouses and distribution centers.

Note 25 The electronic book reader sold by Amazon. Sales started in 2007.

When the rate of online shopping utilization by households in Japan is viewed by age of the head of household, it is apparent that utilization has increased in all age groups over the past decade or so (Figure 1-3-12). The average individual utilization rate for all age groups exceeds 70%, and seen by age group, the rate of utilization by ages 60 and over somewhat exceeds the figures for people in their 30s and people in their 20s or younger (Figure 1-3-13).

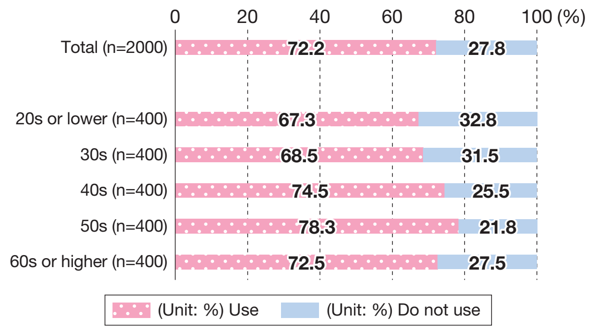
The number of online shopping users is growing year by year, and the purchasing methods used by the Japanese people are undergoing change. It is possible that the advantage of not having to go to a brick-and-mortar store could provide a solution to the issue of elderly people and other "shopping refugees" who are searching for places to buy the goods they need. Further increasing use can therefore be expected. Meanwhile, the increase in users has recently been bringing dramatic rises in the number of items handled by home delivery services, but the logistics industry is facing an increasingly serious shortage of truck drivers. The burden on home delivery service operators has been growing. In the context of innovations being made in the process by which consumers obtain access to goods and services, make purchasing decisions, and settle their accounts, the situation as it is now demands the understanding and cooperation of merchants and service users with regard to the logistics capability that should be in place to actually deliver goods to the consumer.

Figure 1-3-12 Online Shopping Utilization Rate by Age of Head of Household (Households of Two People or More, 2002 and 2014)



Source) Prepared by the MLIT from the "FY2015 White Paper on Information and Communications in Japan"

Figure 1-3-13 Online Shopping Utilization Rates (Individuals)

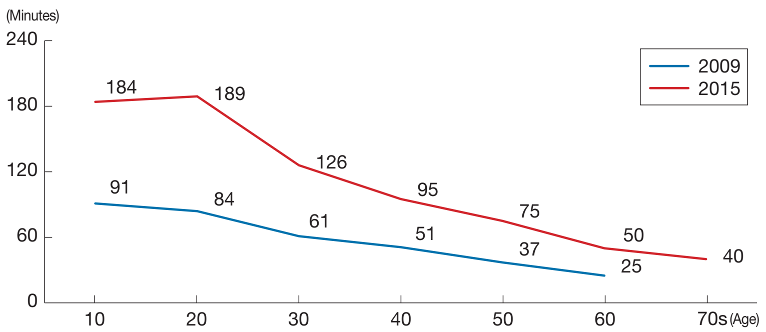


Source) Prepared by the MLIT from the Ministry of Internal Affairs and Communications' "Study Report on People's Awareness of New ICT Services and Technology for Resolving Social Issues" (2015)

■ Search and retrieval engines

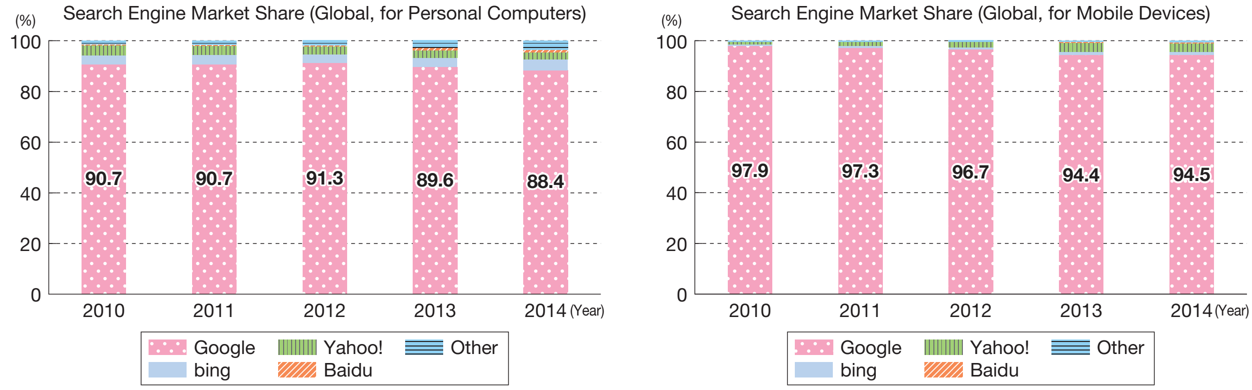
As the Internet has become a familiar presence, time spent online by the Japanese people in their daily lives has been increasing (Figure 1-3-14). It used to be almost entirely through the mass media that the Japanese people had opportunities to come in contact with information. Now, however, there are growing opportunities to obtain direct access to information of various kinds through the Internet. When doing so, people most often use search and retrieval engines to look for information. The global share of search and retrieval engines is largely taken exclusively by Google (Figure 1-3-15).

Figure 1-3-14 Changes in Hours Per Day Spent Using the Internet (Excluding Use at Work) (Weekdays)



Source) Prepared by the MLIT from Nomura Research Institute, Ltd.'s "Questionnaire Survey of 10,000 Consumers" (November 2015)

Figure 1-3-15 **Global Share of Search and Retrieval Engines**



Source) Prepared by the MLIT from the "2014 White Paper on Information and Communications in Japan"

Search engine companies obtain a large part of their revenue from the advertisements that are displayed after a search. At Google, approximately 90% of all company revenue[Note 26] is from search-linked advertising based on advertising programs called AdWords and AdSense. In 1995, two Stanford University students created a search engine (then known as BackRub) that ranked web pages by importance using their links. This was the beginning of the present-day Google.

Google's search algorithms are updated 500 or more times in the course of a year. Algorithms are combined to determine a unique search order, and in order to assure that "Democracy on the web works"[Note 27] in those results, research and development are pursued in order to continue making changes. The developed functions include universal search, which simultaneously displays multiple instances of digital content in a mix of different types; knowledge graphs, which provide a concise display of related information matched to the phenomenon searched for; Google Instant, which displays search results even while the person searching is entering search terms; and Google Suggest, which predicts search terms themselves.

Google enforces a "20% rule" in order to generate innovation. The rule is that all employees are given 20% of their working hours to engage in projects they want to pursue apart from their regular duties. As long as it does not interfere with their regular duties, employees have complete freedom in deciding when to exercise the 20% rule.

Immediately after the Great East Japan Earthquake struck, Google employees in countries around the world invoked this "20% rule" to develop disaster assistance tools using digital technology and to engage in other such crisis response activities. The manager of the Crisis Response team[Note 28] contacted the Tokyo office and asked it to launch the Person Finder[Note 29], the company's service to find people and confirm their status after a disaster. This led volunteers to start gathering independently, and the company's crisis response got underway. One hour and 46 minutes after the disaster hit, they had put up a special Crisis Response site that provided as one of its public services a Japanese language version of the Person Finder. Seven and a half hours later, the Person Finder that had only been usable by personal computer was now configured for use on mobile phones as well.

Another service said to have been produced in a similar way by the 20% rule is Google Maps. Up until 2005, Google Maps had been fee-based, but then the external interface providing the service was made openly accessible at no fee. It became possible for other companies to provide a combination of their information with map information, and numerous location-based services were established. By combining existing technologies, it became possible to move maps in a browser and change their size without having to reload the maps multiple times. Systems became further able to display search results on maps, so that when combined with GPS, they allowed users to find the distance from their current posi-

Note 26 From Alphabet Annual Report for FY2015.

Note 27 One of the "Ten things we know to be true" that state Google's stance. This arrangement is said to treat the quality and number of links to a page, and other such factors, as "votes" that are analyzed using a proprietary algorithm to determine the page's importance, so that items that rank higher appear at the top of the search results.

Note 28 This is a team that is permanently in place to respond to natural disasters in every country in the world. It is made up of employees whose duty is disaster response.

Note 29 This is a service introduced by Crisis Response after the Haiti earthquake in January 2010. Enter a name to search for, and the service checks for information about whether or not that person is safe.

tion to the search result as well as the route and travel time to that location, and other such information.

Google services are not just for searching websites. Operating in coordination with smartphones and the widespread adoption of GPS, they are also having a major impact on emergency information and confirmation of people's whereabouts during disasters, on enhancement of people's mobility, on people's actions during sightseeing, and so on.

Column The First Industrial Revolution and the Luddite Movement

During the first Industrial Revolution, technological innovation brought about mass production, cost reductions, stable quality, and had other fortunate effects on society as a whole. Then again, some workers experienced the disadvantageous, dark underside of the Industrial Revolution, and one of the events arising out of the underside was the Luddite movement.[Note]

Before the first Industrial Revolution, hand-operated looms were introduced in England's textile producing regions, and large numbers of workers earned their living as weavers. The first Industrial Revolution brought about the increasing mechanization of looms, and spinning machines powered by water or steam began to appear. These developments caused a great many workers to lose their livelihoods. Technological innovations led to mechanization, which led to unemployment among highly paid, skilled workers, and the working environment deteriorated for unskilled workers, who now faced abusive conditions, work shifts that lasted far into the night, and other unfortunate changes. Workers who saw technology as the cause of their problems began destroying machinery and factory buildings. Yet the Luddite movement went beyond mere destruction. It can be called a form of collective negotiation between workers seeking improvements in the working environment, and their managers.

The British government enacted laws that decreed punishment, including death, for such actions, but since the Luddite movement enjoyed popular support, these laws were unable to stop the destruction, and it continued for a long time, resulting in the damage to factories and machines from 1811 to 1817, as well as large numbers of casualties and arrests.

Nowadays, the evolution of information and communication technology (ICT) has brought us to a time when people can receive many kinds of services without human intervention. With ICT automating many types of work that were once done by humans, there is some anxiety that these developments are gradually taking away opportunities for individual employment. For this reason, some advocate impeding development or refraining from using automated services in what we might call a "Neo-Luddite" movement, harking back to the Luddites of the past.

Note The movement is said to have been named after Ned Ludd, a youth who destroyed mechanical looms.

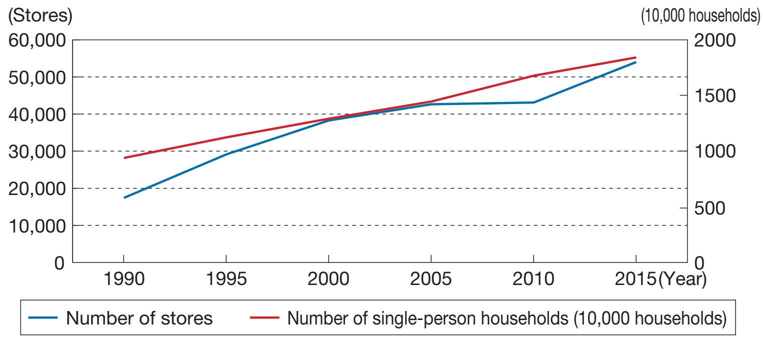
2 Innovation Evolved by Japan

This part introduces some cases of the major changes taking place in the lives of the people, the society, and the economy of Japan due to various innovations.

■ Convenience stores

During the 1970s, supermarkets surpassed department stores in sales and ended up accounting for the largest share of the retail industry. In 1973, the Small and Medium-sized Retail Business Promotion Act was enacted to improve the management capabilities of small and medium-sized business operators and to optimize the operations of specified chain businesses, including franchises. The Large-Scale Retail Stores Law was also enacted at that time to regulate the locations and hours of operation of large-scale chain stores. In that industry environment, convenience stores introduced the franchise system and pursued their own mode of business, operating for long hours and staying open all year round. By doing so, these stores responded to changes in the structure of Japanese society, such as the increasing number of single-person households and the aging of the population (Figure 1-3-16). By pursuing active measures such as the introduction of various services, these stores have been increasing in number (Figure 1-3-17).

Figure 1-3-16 Number of Convenience Stores and Number of Single-Person Households



(Note) Numbers of convenience stores are figures for the fiscal year while numbers of single-person households are figures for the calendar year.
Source) Prepared by the MLIT from the Japan Franchise Association's "Convenience Store Statistics," and the Ministry of Internal Affairs and Communications' "2015 National Census"

Figure 1-3-17 Enhancement of Convenience Store Services

Mid-1970s and on	Start 24-hour operation
Early 1980s	Start home delivery intermediary service
Late 1980s and after	Start business of handling collection of electric and other utility charge payments
Early 1990s	Start banking operations (ATM installation)
Late 1990s to early 2000s	Start ticket sales using multimedia terminals, etc.
Mid-2000s and on	Introduce electronic money
Early 2010s and on	Start mobile sales (shopping assistance) Sales of coffee, baked sweets, other distinctive goods

(Note) Times for launch of some services are given as typical times.
Source) Prepared by the MLIT from information on convenience store companies' websites

Convenience stores are said to have originated in retail stores selling ice in the state of Texas in the United States in 1927. At that time, electric refrigerators had not penetrated to every household, so the ice for ice boxes was an everyday necessity. The Southland Ice Company (now 7-Eleven, Inc.)[Note 30] was established in that year. John Jefferson Green, who was in charge of a retail shop selling ice of that company, was asked by customers to handle food and other items in addition to ice, and the response ended up inaugurating the convenience store business. In 1946, the store chain changed its name to 7-Eleven to reflect their hours of business from 7:00 am to 11:00 pm every day[Note 31].

In Japan, the large supermarket Ito-Yokado was accelerating the rate of store openings in the Tokyo metropolitan area around 1971. With a corporate philosophy of taking steps for mutual coexistence and mutual benefit with local shopping areas, the company decided on a business tie-up with the convenience store business that had already begun in the United States. The Ito-Yokado thinking was that a way to achieve growth with small to medium-sized retail stores would be sure to open up, regardless of the size of the business, if the personnel were hired, productivity was improved, and customer needs were met in a finely tailored manner. The first 7-Eleven[Note 32] store in Japan opened in Toyosu, Koto City, in Tokyo in May 1974. It started 24-hour operation from the following year.

In 1982, 7-Eleven Japan became the first in the world to take the POS system[Note 33] in marketing, which had already been in use in the United States. The POS system can identify not just the total paid, but also when and what items were bought and in what quantities, so the past sales data of a store can be accumulated. For example, the sales data for a holiday in the same month of the previous year can be linked with weather or other such information and can be used to decide (hypothesis) items and quantities to be ordered. Afterward, the actual sales results can be considered (verification), and the conclusions can be reflected in the next orders. This cycle was realized in an arrangement for hypothesis-testing ordering. POS systems resulted in the emergence of ordering systems of this kind, and the company created inventory management methods that minimize stock-out items and excess inventory, and create efficient logistics systems. Joint delivery in which goods from different manufacturers are delivered in the same vehicle was also realized for the first time in Japan in 1980, and new arrangements such as joint delivery and small-lot delivery, and the concept of logistics by specific temperature range emerged from this business. This kind of finely tailored individual item management and ordering responded to changing customer needs while efficiently deploying products even within small stores.

Note 30 In 1991, Seven-Eleven Japan acquired the shares of the Southland Company in the United States, and in 2005 made Southland a subsidiary.

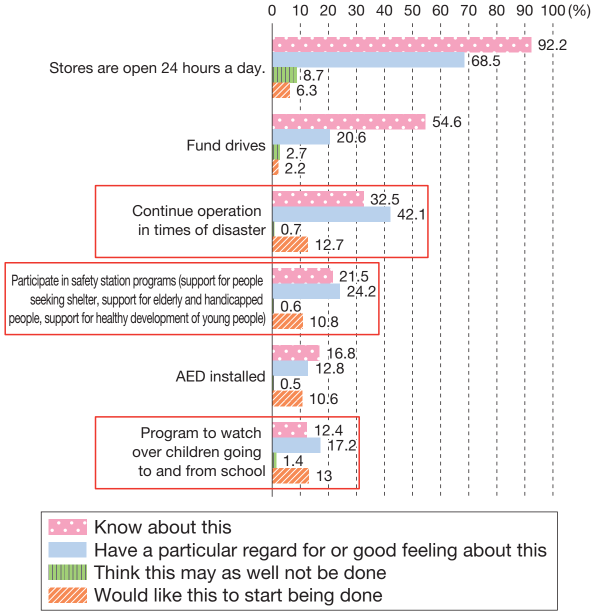
Note 31 In 1971, most 7-Eleven stores began effectively operating on a 24-hour basis.

Note 32 In 1973, the York-Seven Co., Ltd. (which in 1978 was renamed Seven-Eleven Japan) was established. In 2005, Seven & i Holdings Co., Ltd. was established as a holding company with Seven-Eleven Japan Co., Ltd., Ito-Yokado, and other companies as subsidiaries.

Note 33 Point of sale (POS) systems make use of sales records to determine merchandise procurement. These began to be introduced by companies that were expanding their retail business outlets in the United States, and the systems were developed there during the 1970s. The purpose was to make it easier to calculate figures for goods and services sold by each store and to prevent fraud by sales personnel at the cash registers, sales of goods at incorrect prices, and other such problems. POS systems were first introduced at 7-Eleven in 1978.

By providing sales in small quantities of goods oriented to single people, handling the collection of utility charges and other such payments, providing banking services, introducing electronic money, accepting home delivery and postal service items, and other services in a wide range, convenience stores have established themselves not just for retail sales of merchandise, but as stores that have become an established presence for people and local communities. Their functions in society are increasing. Furthermore, those functions are taking on increasing importance as stores remain open for business during disasters, pursue community watch programs, and so on (Figure 1-3-18).

Figure 1-3-18 User Recognition and Evaluation of Convenience Store Activities Contributing to Local Communities



Sources) Created from user questionnaire survey results (n=1,000 ["Know about this;" "Would like this to start being done"], n=958 ["Have a particular regard for or good feeling about this;" "Think this may as well not be done"]; Unit: %)
(Note) Only the six items ranked highest for recognition are shown
Results with multiple responses (up to three) only for "Have a particular regard for or good feeling about this" and others are for multiple responses (any number)
Source) Prepared by the MLIT from the Study Group on Economic and Social Roles of Convenience Stores' "Survey Report on the Economic and Social Roles of Convenience Stores (FY2014)"

■ CVCC engine

In the mid-1960s, Japan was entering an era of motorization, and the air pollution caused by the exhaust gases from motor vehicles had become a serious problem in society. This had also become an urgent issue demanding government response, and in 1966, what was then the Ministry of Transport specified emissions standards for the noxious exhaust gases from motor vehicles. The Basic Act for the Prevention of Pollution was enacted the next year, and the Air Pollution Control Act was enacted in 1968. In 1971, the Environment Agency was established. This was a period of worldwide calls for measures against pollution, and the Muskie Act[Note 34] passed in the United States in 1970 was one response. With the oil shock of 1973, gasoline prices skyrocketed, and there were calls to reduce the fuel consumption of motor vehicles.

In 1966, the Japan Automobile Manufacturers Association organized a research group to observe the current situation of motor vehicle pollution in the United States. The group went to the United States, and among the participants were researchers from the Honda R&D of Honda Motor Co., Ltd. After the group's return, three employees who had been explaining the necessity for air pollution research for some time made an appeal to the director of the Honda R&D Company, and the Air Pollution Research Group (commonly called the AP Lab) was instituted with about 30 personnel. Their work started with research on methods and equipment to measure nitrogen oxides and other such substances. Soichiro Honda, then president of Honda Motor Co., Ltd., took this up as a challenge and pressed the research forward, declaring that "for Honda Motor Co., Ltd., which is the latest manufacturer to enter the automobile industry, this is the perfect opportunity to stand on the same line, engineering-wise, as the other companies." Since it was not possible for Honda to make wholesale changes to production facilities, the company adopted the motto of doing what they could to address the issue with the gasoline engine, and they went through repeated trial-and-error attempts of various kinds. Reasoning that they could hardly catch up with the leading manufacturers by doing the same research as them, Honda decided to take on the challenge of what the other companies were not doing. They aimed for lean combustion using an engine with a subsidiary combustion chamber, something that was not used in conventional gasoline engines.

Note 34 An exhaust gas control law considered at the time to be the most rigorous in the world, and impossible to satisfy. It would not permit the sale of cars that did not reduce the carbon monoxide and hydrocarbons that cause air pollution to one-tenth their previous level by 1975, and nitrogen oxides likewise by 1976.

At that time, the Honda Motor Company did not have water-cooled engines to use in automobile test vehicles, so it had to use engines made by other companies. As a result, Honda was able to collect research data that was more universally applicable. When they reached a stage at which there was hope of reducing toxic components to some extent, President Honda declared in February 1972 that the company expected to clear the Muskie Act requirements, and he publicly presented an overview of a product that he announced would be marketed in 1973. He is said to have told the employees: "If I ask you, you are never going to say it's complete now, no matter how long I wait. If we just wait around for that, the company will collapse first." The patent was still in process, and the company devised a name, Compound Vortex Controlled Combustion (CVCC), that would not allow anyone to identify the mechanism from the name. A full announcement of the product was made in October of that year. It had the appeal of various advantages. It could be used with engines from other manufacturers, for example, and it would enable wide-ranging steps to lower pollution. Since its combustion took place inside the engine, it did not require catalytic converters or other devices to purify the exhaust gases, and there was no risk of secondary pollution. In December of that same year, this product became the first in the world to meet the Muskie Act requirements.

With the momentum from this technology, numerous other emissions reduction techniques were devised, and Japan's emissions reduction technology was raised to the highest level in the world. Now, three-way catalytic devices, electronic fuel injection mechanisms, and other such means have evolved to the point that the CVCC engine has disappeared from the market. It was, however, among the earliest versions of the lean combustion approach that is still being pursued in the present.

■ Automatic ticket gate

Automatic ticket gates were first introduced in Japan in 1927 on the Tokyo Underground Railway (today the Tokyo Metro Ginza Line). These were originally brought in from the New York subway system. When a 10-sen coin was inserted, a lock was unlocked so that a cross arm could be pushed out of the way and just one passenger could pass through the gate. These could be adopted on lines where all the fares were the same. The conventional system was to have a person visually check the information printed or written on a piece of paper and process it accordingly. Subsequently this changed with the appearance of systems that were capable of recognizing the information stored on a magnetic card or other such medium, reading and writing such information, and processing the information. Ticket gate operations were made more efficient and more certain. Trials of such systems started in London in 1963, and research was pursued in Japan, as well.

In the 1960s, the Japanese economy was developing and the population was rapidly moving from farm villages into urban areas. The infrastructure was unable to keep up in various respects, the railroads were terribly crowded during morning and evening commuter rush hours, and this spectacle was dire enough that newspapers around the world reported it as 'morning commuter hell' and other such terms. Long queues formed at the ticket gates, and there was discussion of ways to relieve this congestion in the stations by building machines to carry out ticket gate operations in place of people. In 1964, the Kinki Nippon Railway Co., Ltd., started on joint research with Osaka University, and that same year also called on the equipment manufacturer Tateishi Electric Manufacturing Company (now known as Omron Corporation) to move forward with development. At that time, approximately 80% of passengers used commuter passes, so the work began with development of automatic ticket gates exclusively for commuter passes. In a first step, the idea was conceived of making the machine in a long, narrow shape so that passengers could get back their commuter passes without having to stop and stand waiting. In order to make the system processing speed faster than that of station personnel, the conveyor belt mechanism used in factories was further developed to transport commuter passes through the machine. In order to read the information from the commuter passes, a punch coding system[Note 35] was adopted. A gate bar was installed to block attempts to pass through the ticket gate fraudulently, while at the same time distinguishing between luggage and people. Automatic ticket gates on the same basic pattern used today were completed in 1966. In conjunction with the opening of Senri New Town to new residents and in preparation for the Osaka Expo to follow in three years, the Hankyu Railway opened an extension of its line between Minami-Senri and Kita-Senri. Dual use automatic ticket gates that accepted both commuter passes and regular tickets were installed at Kita-Senri Station, accomplishing the first unmanned ticket gate system in the world. With the way opened, all the major private railways in the Kansai Region and the Osaka Metropolitan

Note 35 This is a method that punches holes about 3 mm in diameter in commuter passes in an arrangement that records information, and that information is read by the ticket gate machine.

Subway adopted automatic ticket gates by the end of 1975.

IC card tickets have also made their appearance in recent years. These IC card tickets are expected to provide faster processing through automatic ticket gates than magnetic card tickets[Note 36]. Trials were done while making changes, such as switching from holding cards above a sensor to touching the card to the sensor, with the result that the IC card ticket performance was improved. Introduction of these tickets has moved forward since 2000.

Automating and speeding up station operations in these ways rationalized railroad management and made it possible for the people of Japan to travel in greater speed and comfort.

■ Management techniques of railroad companies in Japan

Railroad companies in Japan engage in a variety of businesses other than the railroad business, such as real estate, retailing, and so on. The foundation for the management techniques followed by these railroad companies in Japan today are said to have been created by Hankyu Railway, and this portion will review that company and its founder, Ichizo Kobayashi. When Hankaku Railway Co., Ltd., was nationalized, there were sales of property that Ichizo Kobayashi was connected with because he was a banker. When the proceeds from sale of the railroad were used to fund the Minoo Arima Electric Tramway Co., Ltd., he then became involved in the establishment of that company.

The Minoo Arima Electric Tramway followed a suburban route[Note 37] that joined the center of Osaka (at Umeda) with tourist destinations (Minoo, Arima, and so on) in the rural region outside the city. Projections were that the company could not expect very many customers and would face difficulty breaking even. A garden city plan was therefore devised to develop Minoo, which was a famous destination for maple leaf viewing, and its waterfall, Arima, which was famous as a hot spring resort, and other suburban locations. This was a very creative idea for the Japan of that era. The housing situation in Osaka was very poor at that time, with rents rising rapidly, and Kobayashi reasoned that if the population concentrated in Osaka could be moved out to communities along the railway line, a new group of customers would be created that would provide stable revenues from the sale of commuter passes. He also anticipated profit from real estate sales, and started a real estate business in communities along the railway line, selling properties by means of installment loans, which were rare at that time. In this way, Kobayashi started with housing management in areas adjacent to the railway. He then took a series of steps to see that people would also use the railway on holidays by running a zoo, founding a hot spring resort business, building a baseball stadium, and so on. For the inaugural meeting of shareholders in 1908, Kobayashi created a public relations pamphlet titled "The Railway with the Greatest Prospects" (said to be the first such PR pamphlet in Japan). He pursued PR for the railway, and in 1909 created a pamphlet titled "What Kind of Land to Choose and What Kind of House to Live in" as part of his promotion of housing along the railway line. This multifaceted approach to management increased the railroad operator's profitability and contributed to establishing a stable railroad business. At the terminal stations, Kobayashi also built department stores that found customers in the people who took the trains from communities along the train lines. This business was conducted with its targets in a different population than the existing department store customers. He built zoos, the Takarazuka Revue Company, and other amusement facilities in areas adjacent to the railway, and sometimes Kobayashi himself even wrote scripts for the Takarazuka Review.

Ichizo Kobayashi engaged in efforts to provide services for the general public, and the lifestyle he envisioned, "to live in houses in a convenient location with a good environment, shop at department stores, enjoy going to the theater, and lead an affluent life," is still relevant to people of the present day. Kobayashi can be said to have enacted innovation in the way he took the lead in management strategy for a mass consumer age. Most railroad companies in Japan subsequently copied those management techniques, so his company is also said to have provided the business model for the railroad companies of today.

Note 36 Experiments by the East Japan Railway Company suggest that, since magnetic card tickets are transported automatically by machine, the processing time inside the ticket gate machine was 0.7 seconds. The IC card, however, is moved through the gate while held in a person's hand, and processing occurs by a single touch of the card, so it was necessary to process it in 0.2 seconds (the time taken for processing between the card and the read-write device is in 0.1 second).

Note 37 In actuality, the Arima portion was not realized, and the line ended up reaching only as far as Takarazuka.

Column

Shared Housing for Child Rearing

There is a shared housing complex in Tokyo's Daikanyama neighborhood based on the concept of support for child rearing. The concept may be summarized as "a form of child rearing in which parents rely on others, are relied on themselves, and help one another." The main target clientele are single parents and those who want to support child rearing. The objective is create an environment in which residents who have children and residents who do not have children can raise children together as they help one another out.

The owner of the property is Tokyu Corporation, which leased some land and a building that it owns in Shibuya City to be renovated into shared housing.

The common areas includes a living room with a "doodle board," where children can exercise their creativity, full unit baths and mini kitchens on each floor to promote bonds between parents and children, and a rooftop with a wooden deck and a household vegetable garden, in addition to an area where children can play barefoot. These are just some of the ways in which Stylio With Daikanyama has been set up as shared housing equipped with facilities and services that allow working parents to share child rearing duties easily. Furthermore, residents and neighbors can take advantage of AsMama, Inc., a "shared childcare" service, for easily accessible help with concerns about child rearing, and Kids' Security, a children's security service using smart cards from Tokyu Security Co., Ltd. All together, these services create an environment in which single parents can both work and raise their children without undue worry.

Twenty-one households occupy the property, including seven households with children and fourteen households made up of single people.[Note] Special events are held for residents four times a year, and residents say that bringing up children is no longer a lonely task, that when they come home from work they have people to talk to and people to enjoy themselves with, all of which is very encouraging. The children who live here develop their social and communication skills in everyday life and play.

Shared housing of all types is gaining popularity in our society, but this shared housing complex motivates links between people who are raising children and young people who want to support child rearing. This kind of housing will be increasingly important with the increase in nuclear families and as all generations experience the weakening of personal ties. Fostering an environment in which strangers become a large, extended family, and have contact with nature while sharing child care duties, is an emotionally enriching experience for everyone involved.

Figure 1-3-19 Stylio With Daikanyama

Source) Tokyu Corporation

Figure 1-3-20 Household Rooftop Vegetable Garden

Source) Tokyu Corporation

Note Survey as of April 1, 2017