EU-Japan Centre for Industrial Cooperation

Opportunities for venture firms, universities, and research institutes in the EU to conduct knowledge transfer with Japanese counterparts in nine digital technology areas

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Executive Summary

The purpose of this report is to show a map of opportunities for venture firms, universities and research institutes in the EU to conduct knowledge transfer with Japanese counterparts in nine digital technology areas: automated driving technology, cybersecurity, fintech (financial technology), blockchain technology, edtech (education technology), martech (marketing technology), game, IT for fashion business, and IT for art and music business.

For this purpose, this report identifies several key factors to be taken into consideration, including technology development trends, relevant industry policies and social backgrounds, the technology areas to be targeted, potential Japanese counterparts, potential rivals, and business events through which to approach potential Japanese partners and investors.

This report also provides several policy recommendations for policymakers in terms of facilitating knowledge transfer from EU entities to Japanese counterparts.

Contents

Abbreviations

AI	Artificial Intelligence
EUR	Euro
GBP	Great Britain Pound
IoT	Internet of Things
IT	Information Technology
JPY	Japanese Yen
METI	Ministry of Economy, Trade and Industry (of the Japanese government)
USD	United States Dollar

Introduction

The advancement of digital technologies is one of the most important forces for innovation. Innovation - the transformation of novel ideas into marketable products – can bring prosperity and economic growth. Innovation is a force causing major shift in the paradigms of daily life. All over the world, national leaders are looking to innovation and entrepreneurship to revive economies. Business leaders espouse innovation as the means of creating new revenues and shareholder value. Companies promote their capability to be innovative to attract customers and recruit high-quality employees. Academics conduct R&D to create innovation for society at large.

This is why the creation of cutting-edge digital technologies is a matter of the utmost importance for industry, academia and government in Japan. At the same time, Japan has some weaknesses regarding its R&D capacity in IT. For example, according to a survey published by the Ministry of Economy, Trade and Industry (METI) of the Japanese government, Japan already suffered from a shortage of 170,000 experts in the general IT field in 2015, and will be suffering from a shortage of 790,000 experts in the general IT field in 2030.[1] And, according to the same survey, Japan suffered from a shortage of 15,000 experts in the advanced IT fields of AI, IoT and big data in 2016, and Japan will be suffering from a shortage of 48,000 experts in those advanced IT fields in 2020.

Key Japanese players in industry, academia and government are now attaching the vital importance to nurturing IT experts and upgrading their innovation capacity in a diverse range of digital economy fields. However, to continuously generate digital innovation, Japan needs knowledge transfer from other countries. In fact, there are many Japanese entities that are eager to invest in or ally with cutting-edge ventures, universities, and research institutes in other countries in diverse IT fields.

The purpose of this report is to show a map of opportunities for venture firms, universities and research institutes in the EU to conduct knowledge transfer with Japanese counterparts in nine

[1] METI, 2016, *Study of Recent Trends and Future Estimates Concerning IT Human Resources* (Japanese). Available at: http://www.meti.go.jp/press/2016/06/20160610002/20160610002.html.

digital technology areas: automated driving technology, cybersecurity, fintech (financial technology), blockchain technology, edtech (education technology), martech (marketing technology), game, IT for fashion business, and IT for art and music business.

In order to create a "knowledge transfer opportunity map" in this regard, this report indicates information regarding the following points in each of the nine technology areas:

- technology development trends in Japan;
- examples of particular technology fields that can be targeted for knowledge transfer;
- industry policies and/or social background relevant to the targeted technology;
- examples of Japanese entities engaging in business and/or R&D in the targeted technology area (they can be a partner for or a rival against EU entities in that technology area);
- examples of European entities that have already partnered with or are attracting or may attract attention from Japanese counterparts in the targeted technology area (they can be a rival against EU entities or may provide EU entities with bench mark information about corporate alliance in the targeted technology area);
- examples of entities from other countries than the EU that have already partnered with or are attracting or may attract attention from Japanese counterparts in the targeted technology area (they can be a rival against EU entities or may provide EU entities with bench mark information about corporate alliance in the targeted technology area); and
- examples of events and programs through which EU entities may approach possible Japanese counterparts.

In terms of successfully conducting knowledge transfer with Japanese counterparts, it is of fundamental importance for EU entities to formulate and implement alliance strategies while taking all the above-mentioned factors into consideration.

It is my hope that this report will prove useful to people in industry, academia and government in the EU who wish to promote knowledge transfer with Japanese counterparts in the nine digital technology fields.

1. Automated Driving Technology

1.1 The emergence of the concept of "vehicle-to-everything"

Automated driving technology has emerged as a hot topic worldwide. Being a type of technology available to assist the driver so that elements of the driving task can be transferred to a computer system, and being an important component of Internet of Things (IoT), automated driving technology has "vehicle-to-everything (V2X)" communication as its core concept.

Table 1.1 The concept of vehicle-to-everything
The concept of vehicle-to-everything (V2X) communication consists of various elements, including vehicle-to-vehicle (V2V) communication, vehicle-to-infrastructure (V2I) communication, vehicle-to-pedestrian (V2P) communication, and vehicle-to-home (V2H) communication. For example, vehicle-to-vehicle communication will allow the permanent exchange of information on the position of all vehicles in proximity on the road and help with warnings to avoid crashes. Connectivity makes 'platooning' possible, i.e., a coupling of several vehicles within minimal distance of each other, so that they automatically and simultaneously accelerate or brake.

Not only makers of vehicles or autoparts but also a wide array of IT companies are now competing as well as cooperating with each other, in order to take the lead in developing various elements of automated driving technology.

Artificial intelligence (AI) is the most important element of automated driving, particularly because of its ability to recognize and handle the nearly infinite number of scenarios encountered on the road. Technologies for computer vision, predictive algorithms, decision algorithms, maps, sensors, actuators, simulation, and "vehicle-to-everything (V2X)" communication are also vital elements of automated driving.[2]

In addition, there are diverse technologies supporting R&D activities for the development of automated driving. Examples in this regard include virtual simulation technology for model based development (MBD). Furthermore, there are a wide range of technologies supporting a

[2] For the brief information on the elements of automated driving, see the website of Toyota: http://automatedtoyota.com/elements-of-automated-driving/.

variety of commercial business relating to automated driving. Examples in this respect include technology for telematics insurance products and technology for real-time ridesharing.

1.2 The visions for "Society 5.0" and "Level 4"

Around the world, public authorities in many countries have presented industry promotion visions and plans in support of the development and introduction of automated vehicles. Examples in this regard include the US government's ITS Strategic Plan 2015-2019[3] as well as the initiatives taken by European governments such as the Roadmap on Automated Driving drafted by the European Road Transport Research Advisory Council (ERTRAC),[4] CityMobil2[5] and AdaptIVe[6] within the EU's previous funding scheme called "FP7," the German government's roadmap on ethical guidelines for automated driving,[7] the UK government's Vehicle Technology and Aviation Bill 2017,[8] the Swedish government's Drive Sweden,[9] and the Dutch government's DAVI (Dutch Automated Vehicle Initiative).[10]

Japan is no exception. The automobile industry is the most important backbone of the national and regional economy in Japan. The Japanese government has increasingly intensified its effort to promote the development of automated driving technology in the context of its vision for "Society 5.0."

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[3] The website of the U.S. Department of Transportation (USDOT): https://www.its.dot.gov/factsheets/itsjpo_stratplan.htm.

[4] The roadmap is downloadable from the website of ERTRAC: https://connectedautomateddriving.eu/mediaroom/new-roadmap-automated-driving/.

[5] The website of CityMobil2: http://www.citymobil2.eu/en/.

[6] The website of AdaptIVe: https://www.adaptive-ip.eu/.

[7] The Federal Minister of Transport and Digital Infrastructure of the German government, 2017, Ethics Commission - Automated and Connected Driving. Available at: https://connectedautomateddriving.eu/wp-content/uploads/2017/07/ethic-commission-report.pdf.

[8] Basic information regarding the bill is available from the website of the UK government: https://www.gov.uk/government/collections/vehicle-technology-and-aviation-bill.

[9] Drive Sweden is a Strategic Innovation Program launched by the Swedish government. The program is funded by the Swedish Energy Agency, the Swedish Research Council Formas and Sweden's innovation agency VINNOVA. See the website of Drive Sweden: https://www.drivesweden.net/.

[10] The website of DAVI: http://davi.connekt.nl/.

Table 1.2 What is Society 5.0?

Japan now has the vision of a "super smart society" or "Society 5.0" in the context of the so-called "fourth industrial revolution," as mentioned in the 5th Science and Technology Plan of the Japanese government.[11] In the 5th Plan, a super smart society or Society 5.0 is defined as "a society where 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." For the realization of Society 5.0, the Japanese government stresses the significance of developing cutting-edge technology for IoT, big data analytics, high-speed processing device, AI (artificial intelligence), networking, edge-computing and cybersecurity as the "fundamental technologies necessary to build the super smart society service platform." The "super smart society service platform" allows for coordination and collaboration between multiple IoT systems and for a wide variety of data to be collected, analyzed and applied across all the coordinating systems to produce new value and services.

In 2016, the Cabinet Office of the Japanese government published the policy paper titled the "Public-Private ITS Initiative/Roadmaps 2016: Toward the Realization of Automated Driving on Highways and Unmanned Autonomous Driving Transport Services in Limited Regions by 2020."[12] Based on the classification of automated driving defined by the National Highway Traffic Safety and Administration (NHTSA) of the US Department of Transportation (see below), this roadmap categorizes driving support methods into four levels, as described in the table below.

[11] Ever since the enactment of the Science and Technology Basic Law in 1995, the Japanese government has formulated the Science and Technology Basic Plan every five years. The 5th Science and Technology Basic Plan covers the period from 2016 to 2020. Available at: http://www8.cao.go.jp/cstp/kihonkeikaku/5basicplan_en.pdf.

[12] The Cabinet Office of the Japanese government (the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society), *Public-Private ITS Initiative/Roadmaps 2016*. Available at http://japan.kantei.go.jp/policy/it/2016/itsinitiative_roadmaps2016.pdf.

Table 1.3　Four levels of automated driving technology

Categories		Outline	Note (responsibility)	Systems that Realize What is Stated in the Left	
Informational[2]		Alerting drivers, etc.	Drivers are responsible for driving.		
Automatic Control Type	Level 1: Stand - alone	Any of the acceleration, steering, or control operations is done by the system.	Drivers are responsible for driving.	Driving Safety Support Systems	
	Level 2: Compounding of systems	More than one of the acceleration, steering, and control operations is done by the system at the same time.	Drivers are responsible for driving. *Drivers need to monitor driving and be ready to resume safe driving at any time.	Semi-Automated Driving Systems	Automated Driving Systems
	Level 3: Advancement of systems	All of the acceleration, steering, and control operations are done by the system. Drivers only act on the request of the system.	The system is responsible for driving (in automated driving mode).[3] *Automated driving in certain transport settings *Drivers do not have to monitor driving (automated driving mode: the system has not requested the driver to drive.)		
	Level 4: Fully automated driving	All of the acceleration, steering, and control operations are done by everything other than drivers. Drivers have no involvement at all.	The system is responsible for driving. *All driving processes are automated.	Fully Automated Driving Systems	

Source: The Cabinet Office of the Japanese government, *Public-Private ITS Initiative/Roadmaps 2016.*

The Japanese government is now looking to give rise to a domestic market for completely automated vehicles (Level 4/ see above) by 2025, and have one out of every five cars autonomous by 2030, as part of the "Society 5.0" initiative. In this regard, Prime Minister Shinzo Abe proudly expressed his vision that people will see self-driving cars ferrying people around Tokyo during the 2020 Olympics and Paralympics at the annual meeting of the Science and Technology in Society forum (STS forum) in Kyoto in October 2015.

1.3 Benefits automated driving technology brings to society at large

Generally speaking, automated driving technology is expected to bring four benefits to society at large in Japan, as described in the table below.

Table 1.4　Four benefits that automated driving technology can bring to society at large in Japan
1.　The first benefit is to prevent traffic accidents. Transferring more and more of the driving task to a computer system means eliminating the human factor which is at the root of many road

accidents. The Ministry of Economy, Trade and Industry (METI) of the Japanese government aims at reducing deaths from traffic accidents to a tenth of 2015's 4,100-plus fatalities by 2030.[13]

2. The second benefit is to alleviate traffic jams to reduce environmental burdens through automated driving. Traffic congestion is one of the major factors for the CO2 emissions from automobiles, while also having caused economic losses amounting to JPY 12 trillion yen, and time losses amounting to 5.6 billion person-hours.[14] The Japanese government has a target of reducing the amount of traffic congestion to 50% of 2010's figure by 2020.[15]

3. The third benefit is to help the elderly and disabled people to safely drive a vehicle. Some seven million people now fit that description, chiefly elderly people living in rural areas. The Japanese government seeks to reduce the number of people with impaired access to transportation to a tenth of the current sum by 2020.

4. The final benefit is to improve transport conditions in underpopulated areas.

1.4 The Japanese government's initiatives for the promotion of automated driving technology

Rule-making initiatives

Policy makers around the world have now actively engaged in designing the appropriate legal and regulatory framework at the domestic and international levels so that emerging automated driving technologies can be used properly for the benefit of society.

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[13] *Nikkei Shimbun*, the article as of 13th September 2016 (Japanese). Available at: https://www.nikkei.com/article/DGXLASDF12H1E_S6A910C1EE8000/.

[14] The website of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT): http://www.mlit.go.jp/kokusai/itf/kokusai_itf_000006.html.

[15] The ITS Task Force within the Cabinet Office of the Japanese government, 2010, p6. Available at: http://www.kantei.go.jp/jp/singi/it2/its/dai1/siryou5.pdf.

In Japan, many companies are now engaging in automated driving car tests on public roads as well as private sites in Japan. In this regard, in June 2017, the National Police Agency officially released the guidelines for tests of remote-controlled automated driving vehicles on public roads.[16] On the other hand, an expert committee created within the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of the Japanese government has engaged in discussions about who would be legally responsible in case of an accident involving an automated driving car.[17]

At the international level, the Japanese government has been active in contributing to the development of UN Regulations regarding the international technical standards for automated driving systems within the framework of the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29).[18]

International standardization of automated driving technologies

The Japanese government has also actively promoted the international standardization of Japanese technology for ITS (intelligent transportation systems), a part of which is its automated driving technology, especially through discussions at ISO/TC 204, which is the technical committee for ITS standardization within ISO (International Standardization for Standardization).[19] Japanese Industrial Standards Committee (JISC) officially represents Japan at ISO/TC 204, while it has designated the Society of Automotive Engineers of Japan (JSAE)[20] as the entity to carry out the practical international standardization activities for ISO/TC 204 on behalf of JISC.

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[16] The guidelines downloadable from the website of NPA (Japanese): https://www.npa.go.jp/laws/notification/koutuu/kouki/290601koukih92.pdf.

[17] The website of the expert committee on legal responsibility issues regarding the liability for damages relating to automated driving vehicles within MLIT (Japanese): http://www.mlit.go.jp/jidosha/jidosha_tk2_000048.html.

[18] The website of UNECE WP.29: https://www.unece.org/trans/main/wp29/introduction.html.

[19] ISO/TC 204 was set up in 1992 and went into operation the following year. Under ISO/TC 2014, there are currently 12 active working groups corresponding to different areas of ITS. The ITS National Committee within JSAE has sent many Japanese experts from its member companies or industry associations to participate in various activities of ISO/TC 204. See JSAE, 2015, *ITS Standardization Activity in Japan*. Available at: http://www.jsae.or.jp/01info/its/2015_bro_e.pdf.

[20] JSAE, established in 1947, is the largest automobile industry association with about 500 corporate members and 50,000 individual members. JSAE promotes the development of wide-ranging Japanese technologies for automobiles. And, the ITS National Committee within JSAE has functioned to promote the international standardization of Japanese ITS technologies for ISO/TC 204. See the website of JSAE: http://www.jsae.or.jp/index_e.php.

EU-Japan partnership for the connection of the satellite systems

The Japanese government and the EU government plan to connect their global positioning systems to speed up the development of autonomous driving technology.[21] If all goes as planned, Japan's Quasi-Zenith Satellite System and the EU's Galileo will be linked as early as 2018. The link will be a common digital language that the systems will use to transmit information. This will allow automated driving cars and autoparts developed for the Japanese market to be shipped and used outside Japan.

1.5 Possible technology areas for knowledge transfer with Japanese entities

A wide range of Japanese companies doing business in the automated driving field, including Toyota, Nissan and Honda, have been highly motivated to invest in or ally with high tech ventures around the world. There are an increasing number of chances for EU entities with cutting-edge technologies to conduct knowledge transfer with key Japanese players in this respect. And, the fact that the number of Japanese experts in the relevant technology fields such as AI and blockchain is still limited has added to the motivation for Japanese key players to turn their keen attention to a growing number of high tech companies in foreign countries, including EU member states. As stated in Introduction of this report, according to METI, in 2016, Japan already suffered from a shortage of 15,000 experts in the advanced IT fields of AI, IoT and big data, and in 2020, Japan will be suffering from a shortage of 48,000 experts in those advanced IT fields.[22]

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[21] *Nikkei Shimbun*, the online article as of 24th July 2016 (Japanese). Available at: https://www.nikkei.com/article/DGXLASFS07H2T_T20C16A7MM8000/.

[22] METI, 2016, *Study of Recent Trends and Future Estimates Concerning IT Human Resources* (Japanese). Available at: http://www.meti.go.jp/press/2016/06/20160610002/20160610002.html.

The following are examples of possible areas for European entities to have alliance relationship with Japanese entities in this regard:

Table 1.5 Possible automated driving technology areas for knowledge transfer with Japanese counterparts
• Knowledge transfer opportunities with R&D and venture capital arms of Toyota Motors
• Knowledge transfer opportunities with R&D and venture capital arms of Nissan
• Knowledge transfer opportunities with R&D and venture capital arms of Honda
• Knowledge transfer opportunities with Japanese electronics companies
• Knowledge transfer opportunities in the field of onboard processors
• Knowledge transfer opportunities in the field of high definition map technology for automated driving
• Knowledge transfer opportunities in the field of voice recognition technology
• Knowledge transfer opportunities in the field of technology for vehicle firmware updates over the air
• Knowledge transfer opportunities in the field of technology for ridesharing services and automated shuttles
• Knowledge transfer opportunities in the field of telematics insurance
• Knowledge transfer opportunities in the field of virtual simulation technology for model based development (MBD)

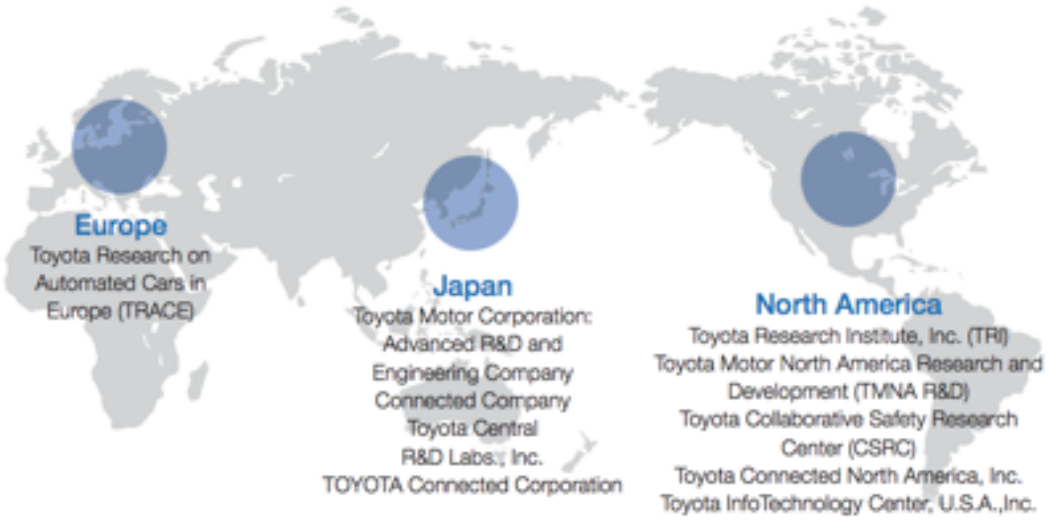
1.6 Knowledge transfer opportunities with R&D and venture capital arms of Toyota Motors

Toyota's vision for automated driving and its world-wide R&D strategy

Toyota has maintained its long-held stance of prioritizing the improvement of safety with the ultimate goal of eliminating casualties from traffic accidents. In order to achieve this ultimate goal by partnering with cutting-edge ventures and research institutes around the world, Toyota has expanded its R&D and venture capital arms not only in Japan but also in the US and Europe, as shown in the figure below.[23]

[23] Toyota Motors, *Toyota Annual Report 2017*. Available at: http://www.toyota-global.com/pages/contents/investors/ir_library/annual/pdf/2017/annual_report_2017_fie.pdf

Figure 1.1 Toyota's automated driving technology R&D framework



Source: Toyota Motors, *Toyota Annual Report 2017*.

Toyota Research Institute (TRI)

Toyota has been very active, through its various R&D and venture capital arms, in investing in or allying with diverse high-tech ventures around the world. One of the typical initiative taken by Toyota in this regard is the establishment of Toyota Research Institute (TRI).

TRI was established in Palo Alto in the US state of California, a five-minute drive from Stanford University in 2015. Since then, TRI has been run under the leadership of its CEO, Gill Pratt, a noted AI expert who was involved, as a program manager, in multiple robotics-related projects at the Defense Advanced Research Projects Agency (DARPA) of the US government from 2010 to 2015. TRI has USD 1 billion to spend during the next five years. With this large budget, TRI is now promoting the R&D regarding various automated driving technologies in collaboration with high tech ventures around the world, with the aim of facilitating the following things: enhancing the safety of automobiles; increasing access to cars to those who otherwise cannot drive; translating Toyota's expertise in creating products for outdoor mobility into products for indoor mobility; and accelerating scientific discovery by applying techniques from artificial intelligence and machine learning.

Examples of TRI's alliance with IT ventures around the world

One of the technology areas that TRI is focusing on is the application of blockchain technology to a variety of automated driving systems for the vision of "vehicle-to-everything (V2X)." While hundreds of billions of miles of human driving data may be needed to develop safe and reliable autonomous vehicles, various advantages of blockchain technology, such as the data continuation through the P2P network, zero downtime system, resilience against falsification and cyberattacks, and low server costs, can make a significant contribution to the development of automated driving systems. (For the information on blockchain technology, see Section 4 "Blockchain Technology" of this report).

In this regard, TRI has partnered with MIT's Media Lab to enlist a series of ventures that specialize in different aspects of blockchain technology, and have been working with the following ventures to explore how blockchain technology may be applied to the development of various services relating to automated driving systems. Examples of ventures that TRI has partnered with in this regard are mentioned in the table below,

Table 1.6 Examples of TRI's alliance with cutting-edge ventures in the blockchain technology area

BigchainDB (Germany)	BigchainDB is a Berlin-based venture that is building a data exchange prototype that allows data providers to upload datasets and data consumers to search, buy and rate data.
Oaken Innovations (USA)	Oaken Innovations is a US-based venture that is developing a blockchain-based system that allows people to register their vehicles for short-term lease and allows payments to be made by cryptocurrency.
Gem (USA)	Gem is a US-based venture that is working with Toyota Insurance Management Solutions (TIMS), which is Toyota's joint venture telematics car insurance company. For the information regarding telematics insurance, see below.
Commuterz (Israel)	Commuterz is a startup from Israel that is working with TRI on a P2P carpooling solution.

In addition, TRI has established joint AI research centers with MIT, Stanford University and the University of Michigan in the USA.

Table 1.7 TRI's alliance with MIT, Stanford and the University of Michigan	
MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) [24]	At CSAIL, researchers pursue a broad spectrum of projects from parallel autonomy to self-awareness.
Sail-Toyota Center for Research for AI Research at Stanford University[25]	Stanford's SAIL is engaged in projects including human-computer and human-robot interactions.
The U-M/Toyota Research Institute Partnership[26]	Research at the University of Michigan focuses on artificial intelligence, robotics and autonomous driving.

TRI-AD

For the purpose of "joint development of fully-integrated, production-quality software for automated driving," Toyota will establish a new company called Toyota Research Institute-Advanced Development (TRI-AD) in Tokyo in March 2018, in conjunction with its two group companies, namely Aisin Seiki and Denso.[27] Those three companies plan to invest USD 2.8 billion into TRI-AD in the coming years and hire around 1,000 employees for the purpose of developing software systems that can power fully self-driving vehicles. Dr. James Kuffner, currently TRI Chief Technology Officer, will lead TRI-AD as its CEO. TRI-AD is expected to expand TRI's or Toyota's alliance with high-tech ventures around the world.

Toyota AI Ventures

In 2017, TRI invested a USD 100 million to create a venture capital fund named Toyota AI Ventures in Silicon Valley.[28] Toyota AI Ventures plans to invest in companies developing solutions in artificial intelligence (AI), robotics, autonomous mobility, data, and cloud technology that share TRI's mission of improving the quality of human life through AI. Through its investment activity, Toyota AI Ventures aims to establish an investment model in which it identifies key research challenges and then supports the creation of new companies to solve them. Since the establishment, Toyota AI Ventures has invested in the AI ventures mentioned in the table below.

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[24] The website of CSAIL: https://toyota.csail.mit.edu/.

[25] The website of Stanford University: https://aicenter.stanford.edu/.

[26] The website of the University of Michigan: http://bec.umich.edu/um-tri/.

[27] The press release as of 2nd March 2018 published by Toyota Motor: https://newsroom.toyota.co.jp/en/corporate/21315381.html.

[28] The website of Toyota AI: https://toyota-ai.ventures/.

Table 1.8 Examples of Toyota AI Ventures' alliance with ventures around the world	
SLAMcore (UK)	SLAMcore develops advanced algorithms designed to help technology platforms such as autonomous cars, drones, and AR/VR systems to simultaneously build a map of their surroundings and position themselves within it. SLAMcore approaches this challenge with a core focus on power efficiency, a crucial factor for autonomous mobility applications given the need to maximize the power available for locomotion.
Nauto (USA)	Nauto provides a AI-based technology system for professional drivers and fleet managers that monitors drivers and the road environment to prevent collisions improve driver behavior, and learn from the diverse data shared across its smart cloud network. The Nauto device is packed with AI-powered sensors that provides powerful visual context inside and outside the vehicle and collects data that can provide meaningful insights.
Connected Signals (USA)	Connected Signals is a connected vehicle data analytics company that provides predictive, real-time, traffic signal information using existing infrastructure. The collected information can be used to support applications that improve safety, increase fuel efficiency, reduce carbon emissions, and improve traffic flow.
Realtime Robotics (USA)	Realtime Robotics develops a proprietary, special-purpose processor that allows robotic systems to instantly react to their environments, and compute how and where to move as their situation is changing
Intuition Robotics (Israel)	Intuition Robotics is a provider of social companion technology, including its ElliQ active-aging robotic companion. The company's technology is designed to positively impact the lives of millions of older adults by connecting them seamlessly with family and friends, making technology accessible and intuitive, and promoting an active lifestyle.

Toyota's Collaborative Safety Research Center (CSRC)

To reduce traffic accident causalities, Toyota's Collaborative Safety Research Center (CSRC) has engaged in joint research with North American universities, hospitals, and research institutions.[29] In January 2017, CSRC started CSRC Next, a new five-year program. Under this program, CSRC has partnered with eight leading research institutions in North America to set up 11 research projects focused on safely transitioning to emerging modes of mobility by addressing the opportunities and challenges presented by evolving vehicle technologies. With these organizations, Toyota is advancing cutting-edge research with the aim of bringing the goal of zero casualties from traffic accidents closer to reality.

Toyota Research on Automated Cars in Europe (TRACE)

Toyota Motor Europe's advanced research team in Brussels has collaborated with experts across Europe in the field of computer vision for automated cars. It is organized loosely around a lab structure named TRACE (Toyota Research on Automated Cars in Europe).[30] Current European partners involved in TRACE are mentioned in the table below.

Table 1.9 Toyota's European partners in TRACE
KU Leuven (Belgium)
Computer vision groups at the University of Cambridge (UK)
The Max Planck Institute of Informatics at Saarbrücken (Germany)
The Technical University of Prague (Czech Republic)
ETH Zürich (Switzerland)

Current activities of TRACE include state-of-the-art deep learning algorithms for object detection, robust and precise tracking, and full scene segmentation and classification. These technologies can be utilized to conduct real time-free space estimation for path planning and vehicle control. TRACE works closely with other research units within the Toyota family, including Toyota Motor Europe (TME) in Belgium, Toyota Motor Corporation (TMC) in Tokyo, and Toyota Research Institute (TRI) in the USA.

[29] The website of CSRC: https://www.toyota.com/csrc/.

[30] The website of TRACE: https://www.trace-lab.com/.

1.7 Knowledge transfer opportunities with R&D and venture capital arms of Nissan

Nissan's vision for fully automated vehicles

Like Toyota's goal of eliminating casualties from traffic accidents (see above), Nissan, together with its French partner Renault, has the twin goals of "zero emission and zero fatalities." [31] For this goal, Nissan plans to launch more than 10 cars with self-driving technology over the next four years in the United States, Europe, China and Japan by 2020.

The first step taken by Nissan for this goal is its release of a vehicle adopting automated-driving technology by releasing its new Serena model minivan in 2016. The vehicle, the first model to employ Nissan's automated driving technology called ProPilot Assist,[32] can operate in automated-driving mode on highways in a single lane, in order to reduces the risk of accidents arising from carelessness and driver error. The current ProPilot Assist is not a fully autonomous system but a Level 2 Driver Assistance system as defined by the industry standard definitions created by the Society of Automotive Engineering (see the table below).

ProPilot Assist is the first step of a three-stage ramp up to the autonomous urban driving in 2020. Nissan plans to build upon ProPilot Assist with a more advanced system due around 2018 that will allow automated driving across multiple lanes. With that capability, it will be able to autonomously negotiate road hazards as well as change lanes during highway driving. Finally, in 2020, drivers will be offered "intersection autonomy." This system will be capable of navigating city intersections and heavy urban traffic without driver intervention.

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[31] *Nissan Motor Corporation Annual Report 2015*. Available at: https://www.nissan-global.com/EN/DOCUMENT/PDF/AR/2015/AR15_E_All.pdf.

[32] For the information on ProPilot Assist, see the website of Nissan: https://www.nissanusa.com/blog/nissan-propilot-assist.

Table 1.10 The five levels of self-driving autonomy defined by the international Society of Automotive Engineers (SAE)

LEVEL	AUTOMATION TYPE	EXAMPLES	WHERE OPERATIONAL	IF AUTOMATION STOPS WORKING
	Driver performs part or all of the dynamic driving task			
0	**No driving automation**	No driving automation anywhere	Not applicable (no automation)	Not applicable (no automation)
1	**Driver assistance**	Adaptive cruise control OR lane centering (driver supervises)	Limited roads or modes	Driver resumes performing all of the dynamic driving task
2	**Partial driving automation**	Adaptive cruise control AND lane centering (driver supervises)	limited roads or modes	Driver resumes performing all of the dynamic driving task
	Automated Driving System (ADS) performs all of the dynamic driving task			
3	**Automated driving** CONDITIONAL	Automated driving in dense freeway traffic (low speeds)	Limited area, roads, and/or modes	Driver takes over after warning
4	**Automated driving** HIGH	Automated driving within a city center (geo-fenced location)	Limited area, roads, and/or modes	ADS brings vehicle to safe stop
5	**Automated driving** FULL	Automated driving everywhere	Everywhere on-road	ADS brings vehicle to safe stop

Source: Auto Alliance[33]

Alliance Venture created by the Renault–Nissan–Mitsubishi alliance

In 2018, Renault-Nissan-Mitsubishi, one of the world's largest automotive alliances, has launched a USD 1 billion corporate venture capital fund called Alliance Ventures to focus on investments in technologies for AI, network connectivity and electrification.[34] Alliance Ventures has a USD 200 million initial investment, and plans to invest roughly the same amount over the next five years. Alliance Ventures is co-located in Silicon Valley, Paris, Yokohama and Beijing from where it targets technology and business model innovation in vehicle electrification, autonomous systems, car connectivity and new mobility services. Alliance Ventures is the main interface with the Renault-Nissan-Mitsubishi Alliance and its member companies for start-ups, incubators, accelerators, investors and the venture capital ecosystem around the world.

The USD 1 billion commitment puts Renault-Nissan-Mitsubishi in the pole position when it comes to automakers committing to corporate venturing, while the funds of BMW iVentures, GM Ventures and Toyota AI Venture are smaller.

[33] Available at: https://autoalliance.org/wp-content/uploads/2017/07/Automated-Vehicles-Levels-of-Automation.pdf.

[34] The website of Alliance Ventures: https://www.alliance-2022.com/ventures/.

1.8 Knowledge transfer opportunities with R&D and venture capital arms of Honda

Honda's vision for fully automated vehicles

Honda was originally cautious about fully committing to the development of automated driving systems. However, Honda has recently expressed its vision, based on the above-mentioned five levels of self-driving autonomy defined by the international Society of Automotive Engineers (SAE), that it intends to have vehicles capable of Level 3 freeway driving on the market by 2020 and to introduce vehicles with Level 4 autonomous driving capability in 2025.[35]

Honda's Alliance with Google and AI ventures

In line with the strategic goal mentioned above, since 2016, Honda has been working with Waymo, Google's newly independent self-driving car effort, to figure out how to put the tech giant's sensors and software into the automaker's vehicles. The idea behind this partnership is to match and combine the companies' areas of expertise. Google can make a highly capable automated driving system but does not have expertise in making actual cars, while Honda builds millions of cars a year but has so far lagged behind Toyota and Nissan in the competition for the development of automated driving technology.

Table 1.11 Example of Honda's alliance with AI ventures	
SenseTime (China)	Also, in 2017, Honda reached a long-term development agreement with SenseTime, China's leading AI company, to leverage Honda's vehicle control system with SenseTime's AI algorithms to jointly create an autonomous driving solution.[36] The two companies intend to develop computer vision technologies that cover a wider array of driving conditions even in the absence of high-resolution maps.

[35] As mentioned above, in the classification system developed by the international Society of Automotive Engineers (SAE), Level 3, as defined, refers to highly automated driving where the driver still needs to be able to take over the vehicle upon request. Level 4 automation means that the car is capable of handling most driving situations itself, whereas Level 5 is largely theoretical and covers complete automation in any condition.

[36] The press release as of 7th December 2017 published by SenseTime: https://www.sensetime.com/news/98.html.

Honda Innovations

In 2011, Honda established Honda Silicon Valley Lab as the global open innovation hub within Honda R&D Americas in the US. Since then, Honda Silicon Valley Lab has collaborated with Apple and Google to deploy their car navigation software (Apple CarPlay and Android Auto, respectively) to the 2016 Honda Accord. At the same time, Honda Silicon Valley Lab has collaborated with a number of innovators on a wide variety of software and hardware technologies to enhance the in-vehicle experience.

In 2017, Honda renamed Honda Silicon Valley Lab as Honda R&D Innovations, to be known as "Honda Innovations." Honda Innovations' focus areas include connected vehicle/Internet of Things (IoT) services, human machine interface, machine intelligence/robotics, connected services, sharing economy, and so on. As part of Honda's open innovation initiative, Honda Innovations has run two open innovation programs - Honda Xcelerator and Honda Developer Studio – with the aim of discovering and partnering with cutting-edge ventures around the world. And, in order to further promote its outreach to venture firms around the world, Honda Innovations has established partnerships with the three foreign business incubators mentioned in the table below.

Table 1.12 Honda Innovations' alliance with foreign business incubators

- MassChallenge (Boston, Massachusetts)[37]: http://boston.masschallenge.org/
- Drive (Tel Aviv, Israel)[38]: https://www.drivetlv.com/
- equity crowd funding platform OurCrowd (Jerusalem, Israel)[39]: http://blog.ourcrowd.com/

In terms of promoting the knowledge transfer from EU entities to Honda, it will be important for Honda Innovations' outreach activity to be extended to business incubation hubs in the EU.

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[37] MassChallenge is a startup accelerator with the global network of accelerators in Boston, London, Jerusalem, Geneva, and Mexico City. See the press release as of 8th March 2016 published by Honda: https://www.hondainnovations.com/news/honda-masschallenge/.

[38] DRIVE is hosting, growing, and fostering top future mobility startups while providing our partners with the opportunity to obtain early insights into the start-ups' cutting edge technology ahead of their competitors. DRIVE is selecting startups with unique value proposition in the smart mobility domain. DRIVE is the place for entrepreneurs that are looking to apply their ideas and products to the smart mobility field. The website of Drive: https://www.drivetlv.com/.

[39] The press release as of 22nd January 2016 published by OurCrowd: http://blog.ourcrowd.com/press-release-honda-opens-door-to-israeli-tech-community/.

Honda Xcelerator program

Established in 2015, the Honda Xcelerator program is an open innovation program designed to facilitate collaboration between early stage technology startups and global Honda. The Honda Xcelerator program is committed to supporting the creation of transformative products and services through open innovation, and includes the provision of funding for rapid prototyping and access to a collaborative workspace, as well as providing the start-ups with Honda mentors. It focuses on ventures operating in energy innovation, human machine interface, personal mobility, industrial innovation, autonomous vehicles, artificial intelligence, smart materials, and robotics. At CES 2017, Honda Xcelerator showcased its collaborations with the venture partners mentioned in the table below.[40]

Table 1.13 Examples of ventures with which Honda has partnered in Honda Excelerator	
LEIA (US)	LEIA is a technology spin-off of spin-off from Hewlett-Packard laboratories and a developer of a light field display technology platform for mobile devices. LEIA's nanotech-based 3D display provides a natural form of 3D that is easier to look at, which is important for the in-car experience. In partnership with LEIA, Honda has developed a driver's instrumentation display using nano-technology that can provide three-dimensional images, switching seamlessly between different viewing angles for warnings and driver-assistive systems. With this technology, when the driver moves his or her head while looking at the screen, the content changes aspect continuously and allows for multi-view 3D imagery. Honda sees a number of potential applications for this technology, from navigation to traffic information, which can be leveraged to provide a more intuitive, convenient and safe in-cabin experience for customers.
VocalZoom (Israel)	See Table 1.18 below.

[40] The press release as of 5th January 2017 published by Honda: http://hondanews.com/releases/honda-demonstrates-collaborative-technology-at-ces-2017?query=CES.

Expansion of Honda Xcelerator in Europe

Honda Innovations is now expanding its engagement of the start-up acceleration program to its global R&D sites including Europe.[41] Throughout this new program, Honda Innovations will guide the new operation from Germany, covering Europe – as well as other newly established start-up outreach initiatives in Detroit, Japan, and China – so that they establish relationships with candidate start-up innovators around the world. Honda Innovations will provide each new satellite operation with protocols and best practices to identify and engage with start-ups and entrepreneurs who share Honda's vision for transforming mobility. By engaging more deeply with the start-up communities in these regions, the aim is to create win-win opportunities for collaborations between top innovators and Honda.

1.9 Knowledge transfer opportunities with Japanese electronics makers

Japanese electronics companies are also keen on the development of automated driving systems, and have strong interest in partnering with foreign ventures in a variety of automated driving technologies. There are cases where EU companies have created partnerships with Japanese counterparts to co-develop automated driving technologies. Examples in this respect include the partnership between Ficosa (Spain) and Panasonic (Japan) as well as the partnership between Mira (UK) and Horiba (Japan), as mentioned in the table below.

Table 1.14 Examples of European companies that have partnered with Japanese electronics makers in the automated driving field

Ficosa (Spain) / Panasonic (Japan)	In 2017, Panasonic Corporation acquired an additional 20% of shares in Ficosa International, which is a Spanish company that supplies automotive parts and systems.[42] Before the deal, Panasonic had a 49% stake in the issued shares of Ficosa, and this acquisition of the additional shares made Ficosa a consolidated subsidiary of Panasonic. The two companies are now working together to jointly develop products such as

[41] The press release published by Honda: https://hondanews.eu/eu/lt/corporate/media/pressreleases/115344/honda-innovations-launches-start-up-collaboration-programme-in-europe

[42] The press release as of 5th July 2017 published by Panasonic: http://news.panasonic.com/global/press/data/2017/07/en170705-2/en170705-2.html.

	electronic mirror systems, and subsequently secure orders for these new products, and also to develop products such as next-generation cockpit systems and Advanced driver assistance system (ADAS).
Mira (UK) / Horiba (Japan)	In 2015, Horiba acquired the entire business operations of Mira, a UK-based company that provides vehicle engineering consultancy and testing services provider.[43] On the basis of the collaboration with Mira, Horiba intends to expand its business and add new products and services at the cutting-edge of next-generation mobility development, in areas such as autonomous vehicles, electric vehicles and ultra-low fuel consumption vehicles.

On the other hand, Japan's major electronics maker Toshiba is in collaboration with Nagoya University in Japan to utilize its image recognition chips named Visconti 4 in the creation of the obstacle avoidance system it hopes to commercialize by 2020.[44] In the new obstacle avoidance system, the Visconti chip processes the image data captured by the camera to three-dimensionally measure the orientation and distance of stationary objects. The chip combines this with information from the laser sensor for added precision, then creates a map depicting where the object is and how to get around it. Such information enables self-driving cars to navigate roads safely. The Visconti 4 can work even in the dark to recognize objects and ascertain such factors as distance and height.

Japan's another electronics giant Hitachi looks to make a name for itself as a premier producer of automated driving systems. In the Automotive Engineering Exposition 2017 in Yokohama, Hitachi Automotive Systems, a wholly owned subsidiary of Hitachi, showcased a wide range of technologies and products related to automated driving systems.[45]

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[43] The press release as of 14th July 2015 published by Horiba: http://www.horiba.com/corporate-news/news/article/horiba-acquires-uk-based-company-mira-ltd-39703/.

[44] The press release published by Toshiba in October 2016 (Japanese). Available at: https://www.toshiba.co.jp/rdc/detail/1610_01.htm.

[45] The press release as of 17th May 2017 published by Hitachi: http://www.hitachi.com/New/cnews/month/2017/05/170517.html.

1.10 Knowledge transfer opportunities in the field of onboard microprocessors for automated driving systems

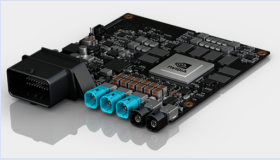
Autonomous vehicles require huge computing power to process and interpret the data from all the sensors on the car by using AI. In this technology area, Japanese automakers are significantly reliant on cutting-edge high-performance onboard microprocessors provided by foreign companies.

Toyota's alliance with Nvidia

For example, in this technology area, Toyota has been in partnership with Nvidia since 2017.[46] Nvidia is an American IT company that designs and provides graphics processing units (GPUs) for AI and deep learning in relation to automated driving systems, among others. Nvidia topped MIT Technology Review's 2017 list of 50 Smartest Companies. Toyota will use Nvidia's AI car computer platform to power advanced autonomous driving systems planned for market introduction.

Table 1.15 Nvidia's AI car computer platform with the next-generation microprocessor

While many prototype vehicles contain a trunk full of computers to handle this complex task, Nvidia's AI car computer platform Nvidia Drive PX equipped with the next-generation microprocessor is small enough to fit in a hand and deliver 30 trillion deep learning operations per second. The AI platform fuses data from cameras, radar and other sensors. The system can then use AI to understand the 360-degree environment surrounding the car, localize itself on an HD map and anticipate potential hazards while driving. In addition, the AI platform receives updates over the air, so the car can become smarter and smarter over time. Nvidia has been in a rivalry relationship with Intel, which has partnered with Nissan (see below).



Source: Nvidia's website[47]

[46] The press release as of 10th May 2017 published by Nvidia: https://nvidianews.nvidia.com/news/nvidia-and-toyota-collaborate-to-accelerate-market-introduction-of-autonomous-cars.

[47] Available at: https://www.nvidia.com/en-us/self-driving-cars/drive-px/

Engineering teams from Toyota and Nvidia are developing advanced software on Nvidia's high-performance AI platform that will enhance the capabilities of Toyota vehicles, enabling them to better understand the massive volume of data generated by sensors on the car, and to handle the broad spectrum of autonomous driving situations.

Nissan's alliance with Mobileye

In 2017, Nissan reached an agreement with Mobileye, an Israeli AI company that develops vision-based advanced driver-assistance systems (ADAS) providing warnings for collision prevention and mitigation. Mobileye was acquired at USD 15.3 billion in 2017 by Intel. Intel has been in a rivalry relationship with Nvidia, which has partnered with Toyota since 2017 (see above). Intel's acquisition of Mobileye can be regarded as a vital part of its competition strategy against Nvidia.

Under this agreement, Nissan integrates Mobileye's new Road Experience Management (REM) technology into Nissan's fleets. Nissan is the third large automaker to have partnered with Mobileye to integrate its new REM technology in addition to General Motors and Volkswagen.

Mobileye REM technology provides real-time data for precise localization and high-definition lane data that forms an important layer of information to support fully autonomous driving. The technology is based on software running on Mobileye's EyeQ processing platforms that extracts landmarks and roadway information at extremely low bandwidths, approximately 10kb per kilometer of driving.

SoftBank's alliance with ARM

In September 2016, SoftBank, one of Japan's largest IT companies, acquired ARM, the UK-based semiconductor firm which designs the chips that power almost every smartphone in the world, for GBP 24 billion in cash. Two weeks after the acquisition, ARM released its new chip called the Cortex-R52 for automated driving vehicles.

One of SoftBank's important strategies behind the acquisition of ARM is to strengthen its competitive standpoint in the global market for automated driving systems. SoftBank has been very active in the R&D regarding automated driving technology. For example, SB Drive, a

subsidiary of SoftBank, has been in partnership with Navya in France as well as with the University of Tokyo in order to introduce Navya's self-driving electric shuttle bus in Japan (see Section 1.15 below).

1.11 Knowledge transfer opportunities in the area of high definition map technology for automated driving

A high-value-added map platform to determine the accurate position of a vehicle in relation to the road is a vital component of automated driving systems. Two European companies, namely HERE and TomTom, have been very active in conducting knowledge transfer/sharing with Japanese counterparts.

Table 1.16 European map technology companies that are increasing their presence in the Japanese map business industry for automated driving systems

- HERE (Netherland): https://www.here.com/en
- TomTom (Netherland): https://www.tomtom.com/en_us/drive/maps-services/maps/

In 2017, HERE signed a partnership agreement with Pioneer, a Japanese company doing world-wide car electronics business, with the aim of co-developing global mapping solutions for automated driving systems.[48] The agreement follows the two companies' recent cooperation exploring the application of Pioneer's 3DLiDAR sensor technology in the development of a data ecosystem for automated driving. Under this agreement, by linking their complementary mapping technologies, HERE and Pioneer plan to enable fully integrated global SD (standard definition) and HD (high definition) mapping solutions in this regard.

In 2017, HERE also teamed up with Mitsubishi Electric for the co-development of ADAS (advanced driver assistance systems).[49] The companies' initial focus is on providing services that, for example, would support smart lane-level guidance for vehicles based on real-time

[48] The press release as of 8th February 2017 published by Pioneer: http://global.pioneer/en/news/press/2017/pdf/0208-1.pdf.

[49] The press release as of 27th October 2017 published by HERE: https://360.here.com/here-will-join-forces-with-mitsubishi-electric-to-create-new-tech-for-manufacturers.

information about traffic conditions and incidents. They will also evaluate how information from onboard vehicle sensors can be utilized for high-definition map updates. HERE and Mitsubishi Electric intend to enable services initially for automotive customers in North America and Europe, before making them available more broadly. The companies will also work together to define possible services that target other industries beyond the automotive market.

In 2017, HERE also reached a partnership agreement with Dynamic Map Platform, a joint venture of government and industry that is being run under the partnership of Innovation Network Corporation of Japan (INCJ),[50] Mitsubishi Electric, Japan's largest mapmaker Zenrin and 14 other companies including Toyota Motors, Honda and Nissan.[51] Dynamic Map Platform is being promoted under the scheme of the cross-Ministerial Strategic Innovation Promotion Program (SIP) promoted by Council for Science, Technology and Innovation (CSTI) within the Cabinet Office of the Japanese government.[52]

On the other hand, in 2017, TomTom reached an agreement with Zenrin to co-develop technologies for various types of car navigation services.[53]

1.12 Knowledge transfer opportunities in the field of voice recognition technology for automated driving systems

Voice recognition technology is one of the fundamental technologies for automated driving systems. Japanese automakers obviously have a high interest in partnering with companies that have cutting-edge technologies in this field. For example, Toyota has been very active in

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[50] INCJ was established in July 2009 as a venture capital fund based on a public-private partnership between METI and 26 private corporations. INCJ is capitalized at JPY 300 billion, with the Japanese government injecting JPY 286 billion and 26 private corporations providing a further JPY 14 billion. INCJ will be operated for a period of 15 years. See the website of INCJ: http://www.incj.co.jp/english/.

[51] The website of Dynamic Map Platform: http://www.dynamic-maps.co.jp/en/index.html.

[52] The website of the Cabinet Office of the Japanese government regarding the SIP on automated driving systems: http://www8.cao.go.jp/cstp/panhu/sip_english/28-31.pdf.

[53] The press release as of 27th October 2017 published by Zenrin (Japanese): http://www.zenrin.co.jp/news/171027.html.

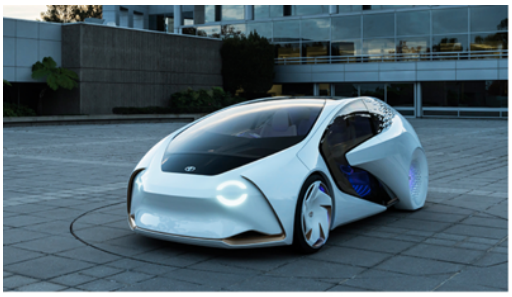
partnering with a variety of US companies in this technology field, as described in the table below.

Table 1.17 Toyota's diverse partnerships in the voice recognition technology area	
Siri – Apple (US)	Toyota's Entune, which is an integrated multimedia navigation and telematics system that provides satellite-based information on traffic, weather, sports scores, stocks, fuel prices and so on, currently uses a version of Apple's Siri voice-activated assistant to help people make phone calls, send emails, or select songs while driving.
Alexa – Amazon (US)	In 2018, Toyota announced its plan to embed Amazon's voice-activated AI assistant named Alexa in vehicles with the Entune 3.0 infotainment system, and Lexus models with the Enform 2.0 system.[54] According to Toyota, with Alexa, drivers and passengers would be able to ask the digital assistant to perform more complex tasks than Siri such as providing driving directions, reading news, controlling Internet-connected home gadgets and performing all the other ask-and-answer functions Alexa delivers in the home application. This announcement marks another step forward by Amazon in getting more third-party devices to use Alexa and beyond Amazon's web-connected speakers like the Echo and Echo Dot.
Microsoft (US)	In 2017, it was announced that Microsoft would give Toyota the license to use many of its connected vehicle technologies, including voice recognition as well as operating system, gesture control, artificial intelligence and cybersecurity tools, although the agreement was not exclusive.[55]
Nuance Communications (US)	In 2018, Nuance Communications, a US based venture that provides conversational AI mechanisms, announced that that its connected car platform Dragon Drive powers the automotive assistant in Toyota's user experience concept vehicle, Toyota Concept-i.[56] Concept-i was showcased at

[54] Jonathan Vanian, "Amazon's Alexa Is Coming to Some Toyota and Lexus Cars," 8th January 2018, *Fortune*. Available at: http://fortune.com/2018/01/09/amazon-alexa-toyota-lexus/.

[55] The press release published as of 22nd March 2017 by Microsoft: https://blogs.microsoft.com/on-the-issues/2017/03/22/microsoft-announces-ip-licensing-program-power-digital-transformation-connected-cars/#sm.00007v5lb82oadv110tcymbmxa9bx.

[56] The press release published as of 9th January 2018 published by Nuance: https://www.nuance.com/about-us/newsroom/press-releases/nuance-toyota-concept-i.html.

	the 2018 Consumer Electronics Show (CES), which took place in Las Vegas in January 2018. Nuance Communications' Dragon Drive is regarded as being in the rivalry relationship with Amazon's Alexa.  Photo of Concept-AI from Toyota's online news release as of 4th January 2017.[57]

Honda is now in partnership, through the Honda Xcelerator program, with VocalZoom to apply its optical microphone technology to improve voice interaction inside Honda's vehicles, as mentioned in Section 1.8 above.

Table 1.18 Honda's partnership in the voice recognition technology area	
VocalZoom (Israel)	VocalZoom is a leading supplier of Human to Machine Communication (HMC) optical sensors that enable a more natural, personalized and secure voice-control experience and has been working with Honda Xcelerator to apply its technology to the in-car experience. VocalZoom's optical sensor "reads" facial skin vibrations during speech, enabling it to isolate a driver's voice from all of the other background sounds in the car. The result is clean, isolated driver commands that are significantly easier for automotive voice-recognition systems to understand and obey than was previously possible with traditional voice-control solutions. In a proof-of-concept demo at Honda's CES display, attendees can experience the VocalZoom technology. VocalZoom has been working with Honda to apply its optical microphone technology to enhance the in-car experience by improving voice interaction inside Honda's vehicles.

There is another example of corporate alliance case for the application of cutting-edge voice recognition technology to automated driving vehicles. In 2017, Sompo Japan Nipponkoa

[57] Available at: https://newsroom.toyota.co.jp/jp/detail/14631005.

Insurance (Japan), Nomura Holdings (Japan), Recruit Holdings (Japan), NVIDIA GPU Ventures (US) and Samsung Catalyst Fund (South Korea) together invested USD 75 million in SoundHound, the US-based leading venture in voice-enabled AI and conversational intelligence technologies.[58] This funding will be used to realize SoundHound's vision of Collective AI through its Houndify platform. Houndify provides all the technology ingredients necessary for voice and AI integration, including the world's fastest speech recognition, sophisticated natural language understanding, easy-to-use developer tools, and knowledge graphs, among others. Hyundai Motor Group (South Korea) will bring Houndfy's voice-enabled AI to their cars starting in 2019.[59]

1.13 Knowledge transfer opportunities in the area of technology for vehicle firmware updates over the air

Another technology area that Japanese automakers have been paying particular attention to is technology for vehicle firmware updates over the air.

Automated driving vehicles have electronic control units containing firmware that enables various functions in the vehicle. New firmware versions are constantly developed to remove bugs and improve functionality. Automobile manufacturers have traditionally performed firmware updates over cables in the service stations on site. To change this situation, the technology for conducting firmware updates over the air, which allows faster updates and improved safety for the driver, is now forthcoming. Interest in this technology area quickly arose after Tesla Motors launched the Model S sedan with onboard Wi-Fi and an electronic architecture allowing every line of code to be changed over time.

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[58] The press release as of 31st January 2017 published by Samsung: https://news.samsung.com/global/soundhound-inc-raises-75-million-to-drive-growth-and-international-expansion-of-houndify-ai-voice-technology-platform-and-collective-ai.

[59] The press release as of 21st December 2017 published by SoundHound: https://blog.soundhound.com/hyundai-cars-powered-by-houndify-af0931c51ee8.

In this regard, Bosch's technology Firmware Over-The-Air (FOTA),[60] which enables the operating firmware of an onboard automated driving device to be wirelessly upgraded and updated without requiring a visit to the repair shop, has received keen attention from Japanese firms.

1.14 Knowledge transfer opportunities in the field of technology for ridesharing services and automated shuttles

Real-time ridesharing services

Toyota has been interested in investing in ventures with technology for real-time ridesharing services, as can be seen in TRI's investment in three ventures with blockchain technology for P2P car sharing, namely BigchainDB in Germany, Oaken Innovations in the US and Commuterz in Israel (see Section 1.6 above).

At the same time, in 2016, Toyota invested in Uber Technologies, the leading American ride-hailing application provider.

Table 1.19 Toyota's alliance with Uber

Uber (US)	Founded in 2009, Uber attracted notice as a fast-growing mobility startup after it launched a ride-hailing service in 2013 that lets customers order a ride through their smartphones. What sets Uber apart from a conventional taxi service is that it relies on freelance drivers, who use their own cars to ferry passengers around. About 1.1 million people around the world work as Uber drivers four times or more per month. Under the partnership with Uber, Toyota offers leasing options for some of the Uber drivers.

Honda is also interested in allying with carsharing ventures. This can be seen in its investment in Grab, an IT company headquartered in Singapore that is regarded as a rival to Uber in the Southeast Asia region.

[60] See the website of Bosch: https://www.bosch-mobility-solutions.com/en/highlights/connected-mobility/updates-over-the-air/.

Table 1.20 Honda's alliance with Grab	
Grab (Singapore)	In 2016, Honda invested in Grab, a venture company that is a rival to Uber in the Southeast Asia region. Grab began as a taxi-hailing app in 2012 to provide motorbike taxis on demand, and is testing new services such as social carpooling, as well as last mile and food deliveries.[61] Grab currently offers services in Singapore, Indonesia, Philippines, Malaysia, Thailand and Vietnam. Before this deal announcement, Grab also announced in 2016 that Japanese financial services company Tokyo Century Corp had made a strategic investment in the firm for an undisclosed amount.

Automated shuttles

Large automakers' investment in technology for ridesharing services may be in line with their strategy for fully automated shuttles and taxis. In fact, Toyota's investment in Uber seems to be a part of its much wider vision of introducing automated driving technologies into various types of mobile services, including ridesharing services, as can be seen in its recently unveiled concept of "e-Palette."

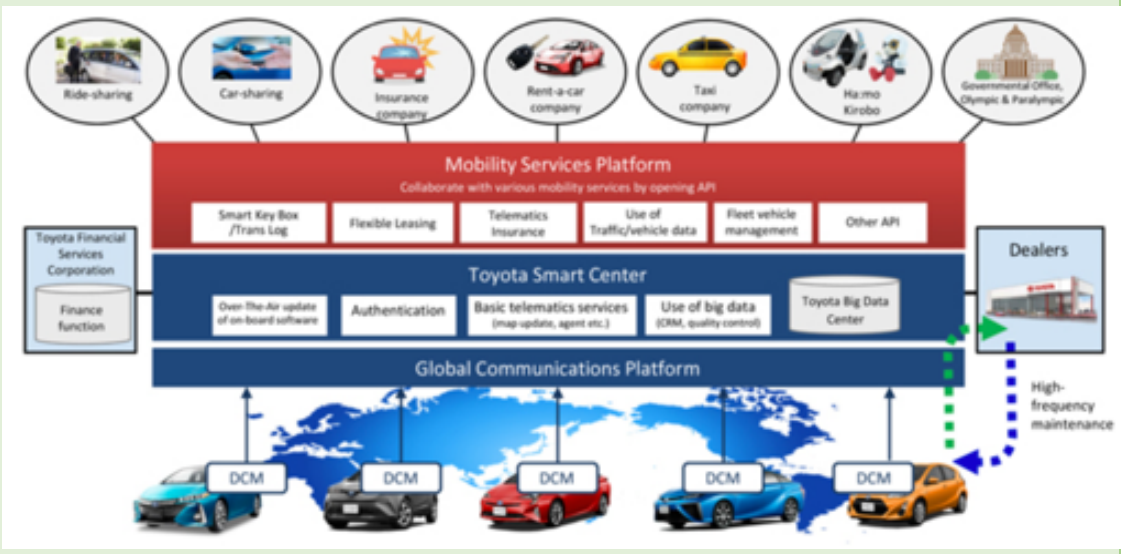
Table 1.21 Toyota's concept of "e-Palette"
In January 2018, Toyota showcased a fully automated electric van called e-Palette at the Las Vegas Consumer Electronics Show, and is now planning trial runs of e-Palette at the 2020 Tokyo Olympics.[62] The e-Palette can be customized by Toyota's partner companies, including Uber, Amazon, and Pizza Hut, into various types of things, such as mobile shops, mobile hotel rooms, mobile research labs, and so on.

[61] The press release as of 12th December 2016 published by Grab: https://www.grab.com/sg/press/business/grab-announces-strategic-partnership-honda/

[62] The news release as of 8th January 2018 published by Toyota: https://newsroom.toyota.co.jp/jp/corporate/20508200.html.

Photo from the website of Toyota.[63]

At the heart of the e-Palette is the Mobility Services Platform (MSPF), a software layer that Toyota is developing to aggregate and comprehend various elements of mobility services, including ridesharing services.[64] Toyota plans to operate the MSPF-based core of the e-Palette as a kind of open innovation platform. This means, for example, that Uber is expected, in theory, to plug its own autonomous-driving software into the MSPF and keep a crucial edge over its ride-hailing rivals within the MSPF framework. This applies to EU ventures that will join this MSPF platform.



The conceptual diagram of MSPF mentioned in the website of Toyota.[65]

[63] Available at: https://newsroom.toyota.co.jp/jp/album/images/20508200/.

[64] The press release as of 31st October 2016 published by Toyota: https://newsroom.toyota.co.jp/en/detail/14097157.

[65] Ibid.

General Motors plans to have its self-driving cars ready for a ride-share service within two years as the automaker looks beyond traditional car ownership for new tech-driven sources of revenue.[66]

The Japanese government aims to improve transport conditions in underpopulated areas in Japan, as stated above. For achieving this goal by deploying automated driving cars in underpopulated areas, two Japanese IT companies, namely Soft Bank and DeNA, have been in partnership with Navya and EasyMile, respectively. Both Navya and EasyMile are French automobile ventures.

Table 1.22 Collaborations between Japanese and French companies in the field of automated driving vehicles for underpopulated areas

Navya (France) / SB Drive (Japan)	In 2017, SB Drive, a subsidiary of SoftBank, completed its first demonstration test of Navya's self-driving electric shuttle bus Arma in Japan at a park in Tokyo in collaboration with researchers from the University of Tokyo's Institute of Industrial Science.[67] The Navya Arma vehicle, developed by Navya SAS, is designed to navigate fixed routes for shuttle bus services while avoiding obstacles. It can carry up to 15 passengers and has a maximum speed of 45 kph. The test attracted more than 800 people in 5 days.  Photo from Navya's website.[68]

[66] Peter Holley, "GM could launch its own autonomous ride-hailing service as early as 2019," 1st December 2017, *The Washington Post*. Available at: https://www.washingtonpost.com/news/innovations/wp/2017/12/01/gm-self-driving-fleet-could-be-biggest-business-opportunity-since-the-creation-of-the-internet/?utm_term=.45a285c63517.

[67] The press release as of 14th July 2017 published by Softbank (Japanese): https://www.softbank.jp/corp/group/sbd/news/press/2017/20170714_01/.

[68] Available at: https://navya.tech/en/navya-enters-the-japanese-market-2/.

	Navya continues its expansion in Asia after sales in Singapore, China (Honk Kong) and now Japan. Today 45 shuttles are deployed all around the world and they have already transported up to 170.000 passengers.
EasyMile (France) / DeNA (Japan)	DeNA, a Japanese e-commerce company, is promoting a shuttle service using EasyMiles's self-driving bus EZ10 in Japan for transportation in districts lacking adequate public transit systems.[69] The EZ10 shuttle from EasyMile is a twelve-person autonomous shuttle first released in 2014, which has been deployed in more than 50 cities across 17 countries in Asia-Pacific, North America, the Middle East and Europe.  Photo from EasySmile's website.[70]

1.15 Knowledge transfer opportunities in the area of telematics insurance

Telematics is a term that combines the words *telecommunications* and *informatics* to broadly describe the integrated use of communications and information technology to transmit, store and receive information from telecommunications devices to remote objects over a network. Telematics insurance is a type of automobile policy that offers discounts based on driving data captured by a smartphone application. Certain smartphone functions capture sudden braking, sharp turns and other behavior behind the wheel. The data is then quantified to provide ratings. The application usually lets drivers know how safely they are operating the vehicle. So-called

[69] The press release as of 7th July 2016 published by DeNA (Japanese): http://dena.com/jp/press/2016/07/07/1/.

[70] Available at: http://www.easymile.com/#Products

telematics insurance policies are more prevalent in Europe and the U.S. than in Japan, where driver ratings based on accident history determine premiums. However, a growing number of Japanese companies are now looking to see increasing business chances for telematics insurance as automated driving vehicles prevail in the Japanese market.

In the field of technology for telematics insurance, TRI is now working with Gem and Toyota Insurance Management Solutions (TIMS), as stated in Table 1.6 above. Toyota is also expanding its telematics services through the activity of Toyota Connected, which Toyota created in partnership with Microsoft in 2016.[71] Toyota Connected uses cutting-edge big data analytics to provide telematics insurance products that base the appropriate premium on how safely the driver drives, among others.[72]

On the other hand, Toyota Motor and Aioi Nissay Dowa Insurance, a Japanese large insurance company, have jointly developed Japan's first driving behavior-based telematics automobile insurance. The plan is available to owners of certain units of Toyota connected cars, and uses driving data gathered via telematics technologies to adjust insurance premiums based on the level of safe driving every month. Total insurance premiums comprise a combination of basic insurance premiums and usage-based insurance and, under this new plan up to 80 percent of usage-based insurance premiums can be discounted.

Aioi Nissay Dowa Insurance has a vision of expanding its business in the European telematics insurance market, as can be seen in its acquisition of Box Innovation Group Limited in the UK.

Table 1.23 The acquisition by Aioi of Box Innovation Group Limited in the UK

Box Innovation (UK) / Aioi Nissay Daiwa Insurance (Japan)	In order to enter into the UK telematics insurance market, in 2014, Aioi Nissay Dowa Insurance acquired 75.01% of the total outstanding shares of Box Innovation Group Limited, which is a major British telematics auto insurance firm based in Gibraltar, for GBP 105 million.[73] Whilst the

[71] The press release as of 4th April 2016 published by Toyota (Japanese): https://newsroom.toyota.co.jp/jp/detail/11609602.

[72] The website of Toyota Connected: http://www.toyotaconnected.co.jp/.

[73] The press release as of 23rd December 2014 published by MS&AD Insurance Group Holdings: http://www.ms-ad-hd.com/en/news_group/pdf/20141223_ADI.pdf.

	telematics auto insurance is currently estimated to represent less than 5% of the total number of auto insurance policies in the UK, it has become clear that advances in technology are likely to result in rapid growth in future.

1.16 Knowledge transfer opportunities in the field of virtual simulation technology for model based development (MBD)

Now many Japanese automakers are paying keen attention to the virtual simulation technology for model based development (MBD) in the context of efficient designing of cars, including automated driving cars.

In the automotive sector, each model year sees the introduction of more advanced systems to meet consumer demand for vehicles that are not only safe and reliable but also comfortable and enjoyable to drive. And, new developments regarding vehicles or materials are mandatory to be tested before manufactures are allowed to produce them for the street. In the tests, strict rules and regulatory requirements have to be followed as a necessary protection of all transport means. This often goes with delays in the product introduction and holds unexpected expenses.

In this respect, the virtual simulation technology for model based development (MBD) provides numerous advantages. Simulations of vehicles or vehicle components in realistic scenarios are not only significantly more cost-efficient compared to real-world testing, and newly developed products can be tested under reproducible conditions independently from physical factors such as the traffic situation or weather. In addition, the virtual simulation technology for MBD helps reduce time to market since potential problems may be discovered and eliminated before the beginning of production without causing high production costs.

Two German companies, namely dSPACE and IPG Automotive, are gaining growing attention from Japanese automakers. dSPACE started as a spin-off from Karlsruhe University, today known as the Karlsruhe Institute of Technology, while IPG Automotive started out of the University of Paderborn. Both of the companies provide virtual simulation services for MBD to

automakers around the world. Both dSPACE and IPG Automotive have their branch office in Tokyo.

Table 1.24 German companies with MBD technology that have gained keen attention in Japan
• dSPACE (Germany): https://www.dspace.com/de/gmb/home.cfm • IPG Automotive (Germany): https://ipg-automotive.com/

There are Japanese automobile companies that used dSPACE's software for R&D purposes. Example of such Japanese companies include Mazda and Denso, as shown in the table below.

Table 1.25 Examples of Japanese companies that used dSPACE's software for R&D purposes	
Mazda (Japan)	Mazda, one of Japan's large automakers, used dSPACE's MBD software when developing its SKYACTIV technology.  Source: dSPACE's website.[74]
Denso (Japan)	Denso, a group company of Toyota, also used dSPACE's MBD software for its R&D project. Long before the first prototypes start their test drives, a vehicle can already be driven and tested virtually. The FMI standard helps the developers of automotive supplier DENSO carry out such virtual test drives with a combination of diverse component models. The basis: simulation platforms by dSPACE.  Source: dSPACE's website.[75]

[74] Available at: https://www.dspace.com/shared/data/pdf/2013/6_11_Aiming%20High.pdf.

[75] Available at: https://www.dspace.com/ja/jpn/home/applicationfields/stories/denso-virtualmodelingtoolbox.cfm.

The German automotive industry is now promoting the standardization of the German virtual simulation technology for MBD through the activity of the industry consortium named PEGASUS with the support of the German government's support.[76]

METI has been interested in the advancement of the virtual simulation technology for MBD as a matter of national automobile industry policy. In 2017, METI established a study group consisting of ten Japanese companies (i.e. Toyota, Honda, Nissan, Mazda, Mitsubishi Electric, Panasonic, Hitachi, Denso, Jatco, and Aisin AW) to promote information sharing among members and upgrade the international competitiveness of Japanese technology in this field.[77]

1.17 Knowledge transfer/sharing opportunities with Japanese universities

Major Japanese universities have actively engaged in the R&D regarding automated driving technology. The table below shows several examples in this respect.

Table 1.26 Examples of Japanese universities engaging in R&D regarding automated driving technology

- The University of Tokyo
  - Advanced Mobility Research Center (ITS Center), Institute of Industrial Science: http://www.its.iis.u-tokyo.ac.jp/index_e.html
  - Kamojo Lab, Institute of Industrial Science, Center for Socio-Global Informatics: http://kmj.iis.u-tokyo.ac.jp/e_index.html
  - PFLab, Department of Computer Science, Graduate School of Information Science and Technology: http://www.pf.is.s.u-tokyo.ac.jp/
- Tokyo Institute of Technology
  - Asakura Lab, Transport Studies Unit: http://asakura.cv.ens.titech.ac.jp/
- University of Tsukuba

[76] The website of PEGASUS: http://www.pegasus-projekt.info/en/about-PEGASUS.

[77] The press release as of 31 March 2017 published by METI: http://www.meti.go.jp/english/press/2017/0331_004.html.

- Laboratory for Cognitive Systems Science: http://www.css.risk.tsukuba.ac.jp/en/index.html

- Nagoya University
  - COI Mobility Innovation Center: http://www.coi.nagoya-u.ac.jp/en
  - TierIV, a spin-off from Nagoya University: https://www.tier4.jp/
- Osaka University
  - Ushio Lab, School of Engineering Science: http://ushiolab.sys.es.osaka-u.ac.jp/index.html
- Kyushu University
  - The Smart Mobility Promotion Consortium: http://www.smpc.jp/outline.html
- Keio University
  - Omae Lab, SFC: http://web.sfc.keio.ac.jp/~omae/automated_driving.html

According to the website of Advanced Mobility Research Center (ITS Center) of the University of Tokyo (see above), one of Japan's largest research centers for automated driving technology, the Center has established research partnership with the European universities mentioned in the table below.

Table 1.27 The international R&D partnerships of ITS Center of the University of Tokyo

France	The French Institute of Science and Technology for Transport, Development and Networks Institut Francais des Sciences et Technologies des Transports, de l'Amenagement et des Reseaux (IFSTTAR)	2007.3-2017.1
Switzerland	Swiss Federal Institute of Technology, Lausanne Ecole Polytechnique Federale, Lausanne (EPFL)	2005.10 - 2015.10
Spain	Center for Innovation in Transport (CENIT) Centre d'Innovacio del Transport	2009.10 - 2014.10
Netherlands	Delft Infrastructure and Mobility Initiative (DIMI), Delft University of Technology Technische Universiteit Delft	2006.2 - 2012.10
United Kingdom	University of Leeds	Planned
France	The National Institute for Research in Computer Science and Control Institut National de Recherche en Informatique et en Automatique (INRIA)	Planned
Sweden	Swedish National Road and Transport Research Institute Vag-och Transport-forskenings Institutet (VTI)	Planned

Source: The website of ITS Center, the University of Tokyo.

2. Cybersecurity

2.1 Japan's vulnerability to cyberattacks

Japan has been targeted by a skyrocketing number of cyberattacks. In 2005, the National Institute of Information Communications Technology (NICT)[78] began its cyberattack survey regarding the number of cyberattacks against all kinds of entities in Japan including governmental organizations, companies, universities and public and private research institutes, and discovered about 310 million cyberattacks. This figure has skyrocketed since then. In 2017, NICT spotted about 150.4 billion attacks in this respect.[79]

One of the most frequently cyberattacked industries in Japan is the financial industry. According to a survey conducted by the Bank of Japan in 2017, 51% of local financial institutions such as banks and credit associations have experienced cyberattacks since 2015.[80] Nearly 11% of respondents said that the attack disrupted their operations. Several banks said that their websites had become inaccessible for a period of time due to the cyberattacks. More than 85% of banks said that the risk of cyberattacks is increasing.

There are many data that show the high level of vulnerability of Japan to various types of cyberattacks. According to Deloitte's Asia-Pacific Defense Outlook 2016,[81] Japan, along with South Korea, Singapore, Australia, and New Zealand, has a cyber vulnerability index nine times higher than their Asian neighbours. The index is based on a number of data points that measure internet-based economic interactions – such as the number of mobile phone subscribers, the number of secure Internet servers, broadband prevalence, and the rate of Internet use – and does not consider the effectiveness of countermeasures in place or the number of Internet-reliant military and government systems. Still, it provides a sign of how vulnerable Japan is. In short, Japan is a high-value target for cyber criminals – militarily, economically, and technologically.

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[78] The website of NICT: https://www.nict.go.jp/.

[79] The survey report (Japanese) is available at NICS' website: http://www.nict.go.jp/press/2018/02/27-1.html.

[80] The survey report (Japanese) is available at: https://www.boj.or.jp/research/brp/fsr/data/fsrb171016.pdf.

[81] Deloitte, *Asia-Pacific Defense Outlook 2016*. Available at: http://www2.deloitte.com/jp/en/pages/public-sector/articles/gv/asia-pacific-defense-outlook-2016.html.

2.2 The Japanese government's domestic initiatives for cybersecurity

Under these serious circumstances, the Japanese government has intensified its effort to formulate and implement various cybersecurity policies, as shown below.

The Basic Act on Cybersecurity 2014

Japan enacted the Basic Act on Cybersecurity in November 2014. This law requires the national and local governments to take measures to boost cybersecurity against various types of cyberattacks and to take measures to improve the skills of those who work in the cybersecurity field, while also obligating businesses relating to infrastructure and IT to endeavor to take voluntary measures to enhance cybersecurity and to cooperate with the government on the implementation of relevant cybersecurity measures.

Cybersecurity Strategy 2015

In September 2015, the Cabinet Office formulated and published Cybersecurity Strategy as the basic foundation of its cybersecurity policy with the prospects ahead for the early 2020s.[82] The 2015 strategy highlights the positive and negative aspects of cyberspace. It emphasizes both the importance of expanding Japan's capacity for IT innovation and the necessity of strong cybersecurity measures.

The 2015 strategy also reiterates the Japanese government's concern over the recent series of massive personal information leaks, such as the case where the Japan Pension Service (JPS) was attacked in May 2015, exposing the personal data of more than 1.2 million people.[83] For this, the Japanese government gave power to NISC (National Center of Incident Readiness and Strategy for Cybersecurity) to audit the operations of JPS and other government-affiliated corporations.

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[82] The Cabinet Office of the Japanese government, 2015, Cybersecurity Strategy. Available at: http://www.nisc.go.jp/eng/pdf/cs-strategy-en.pdf.

[83] This cyberattack case raised particular concerns among policy makers in Japan, as Japan planned to rolled out My Number in 2016, a twelve-digit identification number for Japanese residents to access the country's social security and tax systems, akin to the U.S. Social Security number.

Cybersecurity Guidelines 2015 leading to "cybersecurity momentum" in Japan

In 2014, the Japan Business Federation, better known as Keidanren, created a task force involving 30 major companies encompassing the transport, finance, computer technology and communications sectors. In 2015, this group made recommendations calling on the government to do more in terms of sharing information about cyberattack risks, training human resources and supporting technology development. Keidanren has also taken on the task of raising awareness in the business community that cybersecurity is an essential management task requiring significant investments to reduce associated risks.

In line with this industry initiative, in 2015, METI and Information-Technology Promotion Agency (IPA),[84] which is a METI's policy implementing agency for the training of IT human resources, released a document titled Cybersecurity Management Guidelines.[85] These guidelines require corporate executive officers to: take the leadership to invest in cybersecurity, based on the level of risk they deem acceptable to their business operations; enact cybersecurity measures for their own company, and promote measures in affiliated companies and business partners to mitigate potential information breaches; and communicate their cybersecurity measures to stakeholders, take accountability, and build confidence. The guidelines have given "cybersecurity momentum" to the business community, and has encouraged Japanese companies to release and implement new cybersecurity policies.

2.3 International government initiatives between Japan and foreign countries

Cyber does not respect sovereignty, and domestic solutions are never adequate. No one country can defend cyberspace by itself. In this regard, there has been a growing number of international government initiatives between Japan and foreign countries.

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[84] The website of IPA: https://www.ipa.go.jp/.

[85] METI, 2015, *Cybersecurity Management Guidelines*. Downloadable from the website of METI (Japanese): http://www.meti.go.jp/english/press/2015/1228_03.html.

Cooperation with the EU or its member states

For example, following are several examples of government collaboration between the EU or EU member states and Japan in the cybersecurity field.

Table 2.1 Examples of government-led collaboration between the EU or EU member states and Japan in the cybersecurity field

- The Horizon-2020-oriented research promotion framework between NICT (see above) and the EU under the title of Advanced technologies combining Security, IoT, Cloud and Big data for a hyper-connected society.[86]
- The visit paid by the British delegation from the cybersecurity sector to Tokyo in 2017.[87]
- Third Joint Meeting on Cybersecurity between France and Japan in 2017.[88]
- Tokyo Seminar on Japan-Netherlands cybersecurity collaborations in 2016.[89]
- The Japan-EU symposium on Cyber Security at the Hague Institute for Global Justice in 2016.[90]
- The visit paid in 2018 by Prime Minister Shinzo Abe of the Japanese government to Estonia to agree on the cooperation on cybersecurity between the two countries, among others.[91]
- The third meeting of EU-Japan Cyber Dialogue in Tokyo on 5 March 2018.[92]

The General Data Protection Regulation (GDPR)

The General Data Protection Regulation (GDPR), which is expected to be implemented in the EU in 2018 and to strongly protect and empower all EU citizens' data privacy, may urge

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[86] The website of the European Commission regarding Horizon 2020: http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/euj-01-2018.html.

[87] The "Innovation is Great" campaign website of the U.K. government: https://www.innovationisgreat-jp.com/blog/uk-cyber-security-capabilities/.

[88] The website of the joint meeting on cybersecurity between France and Japan: https://project.inria.fr/FranceJapanICST/3rd-joint-meeting-on-cybersecurity-april-24-26-tokyo-japan/.

[89] The document titled "Tokyo Seminar emphasizes Japan-Netherlands cybersecurity collaborations, build knowledge and expertise" as of 13th January 2017 published by the Embassy of the Kingdom of the Netherlands in Tokyo: https://www.rvo.nl/sites/default/files/2017/01/IAJapan2017_cyber.pdf.

[90] The press release as of 23rd March 2016 published by the Embassy of Japan in the Netherlands: http://www.nl.emb-japan.go.jp/itpr_en/20160315_symposium.html.

[91] *The Japan Times*, the online article as of 13th January 2018 titled "Abe wins cybersecurity support in meeting with Estonian leader Juri Ratas." Available at: https://www.japantimes.co.jp/news/2018/01/13/national/politics-diplomacy/abe-beefs-european-ties-amid-tensions-north-korea/#.WqzmpZPFJhA.

[92] The press release as of 14th March 2018 published by Delegation of the European Union to Japan: https://eeas.europa.eu/delegations/japan/41330/node/41330_en.

Japanese companies doing business in the EU to utilize cybersecurity systems provided by EU counterparts.[93]

Cooperation in the G7

In the G7 Ise-Shima Summit that took place in Japan in May 2016, leaders from Japan, Canada, France, Germany, Italy, the UK, and the US, as well as representatives of the European Union, gathered to address major global economic and political challenges. Notably, for the first time at a G7 Summit, their discussions included cybersecurity.[94] In fact, the G7 Ise-Shima Leaders' Declaration contains several consensus items regarding cybersecurity, reflecting the critical importance and geopolitical consequences of this issue in today's world.[95] Among other things, the Leaders' Declaration endorsed the G7 Principles and Actions on Cyber, the purpose of which is to promote security and stability in cyberspace as well as the digital economy, and to commit the leaders "to take decisive action" regarding those Principles. Cybersecurity came up not only in this Summit, but also in an array of related G7 meetings leading up to it: the G7 Foreign Ministers' Meeting April 10-11, the G7 ICT Ministers' Meeting April 29-30, the G7 Finance Ministers and Central Bank Governors Meeting May 20-21, and the G7 Energy Ministerial Meeting May 1-2 in 2016.

In line with the outcomes from the G7 Ise-Shima Summit, in October 2016, the G7 published the G7 Fundamental Elements of Cybersecurity for the Financial Sector (G7FE).[96] This statement provides a set of effective cybersecurity practices within private entities, public authorities, and the financial sector. It aims to build greater financial system resilience by supporting private and public entities as they design and implement cybersecurity policies and operating frameworks.

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[93] The website of GDPR: https://www.eugdpr.org/.

[94] The website of the Ministory of Foreign Affairs (MOFA) of the Japanese government: http://www.mofa.go.jp/ecm/ec/page4e_000457.html.

[95] The G7 Ise-Shima Leaders' Declaration is downloadable from the website of MOFA: http://www.mofa.go.jp/ecm/ec/page24e_000148.html.

[96] This document is downloadable from the website of the European Commision: https://ec.europa.eu/info/publications/g7-fundamental-elements-cybersecurity-financial-sector_en.

Cooperation with the USA

In 2015, the U.S.-Japan Cyber Defense Policy Working Group issued a joint statement pledging closer cooperation between the United States and Japan on cyber defense issues.[97] In that statement, the working group, set up in October 2013 with an eye on China and North Korea, noted the "growing level of sophistication among malicious cyber actors, including non-state and state-sponsored actors, who are increasingly willing to demonstrate their intent and ability to do harm against information systems, critical infrastructure and services upon which our people, economies, governments, and defense forces rely," and agreed to share best practices and organize, train and equip government entities and corporations to combat cyberattacks. In 2017, the Japanese government and the US government issued a joint statement at the conclusion of the fifth Japan-U.S. Cyber Dialogue with the aim of promoting the information sharing regarding cybersecurity between the two countries, among others.[98]

Initiatives for research collaboration among universities and research institutions in the US and Japan have also been facilitated in the cybersecurity field.[99]

Cooperation with Israel

The government of Israel and the Japanese government have reached a Memorandum of Cooperation in the field of cybersecurity.[100] The Israeli government has now been very active in promoting the knowledge transfer from cutting-edge Israeli cybersecurity ventures to Japanese counterparts. In Cybertech Tokyo in 2017 (see below), a total of 11 Israeli cybersecurity ventures showcased their technologies.[101]

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[97] Joint Statement of the U.S.-Japan Cyber Defense Policy Working Group, 2015. Available at: http://www.mod.go.jp/j/press/news/2015/05/30a_1.pdf.

[98] The press release as of 24th July 2017 published by the US government: https://www.state.gov/r/pa/prs/ps/2017/07/272815.htm.

[99] The press release as of 31st May 2017 published by the American Association for the Advancement of Science: https://www.aaas.org/news/us-japan-research-collaboration-relies-new-and-existing-relationships.

[100] Memorandum of Cooperation in the field of Cybersecurity between the Japanese and Israeli governments, 2017. Available at: http://www.meti.go.jp/press/2017/05/20170508004/20170508004-5.pdf.

[101] Those Israeli cybersecurity ventures are listed in the brochure published by the trade section of the Embassy of Israel in Tokyo: http://www.itrade.gov.il/japan/files/2017/11/CyberTech_Tokyo_2017_Company_List.pdf.

Cooperation with China and South Korea

In 2015, the 3rd Japan-Korea-China Cyber Policy Consultation was held in Korea.[102] At this Dialogue, the three countries discussed the recent environment in the field of cyber affairs as well as the strategies and policies of each country on cyber issues. They also exchanged views on cyber-related efforts such as the United Nations Group of Governmental Experts (UNGGE), among others. The three countries also deepened understanding of each other's policies and agreed on the importance of continuing this dialogue through the discussion on future cooperation in the context of the trilateral partnership.

2.4 Possible technology areas for knowledge transfer with Japanese counterparts

Under the above-mentioned circumstances, chances for EU cybersecurity entities to conduct knowledge transfer with key Japanese players are growing. The table below shows examples of possible cybersecurity technology areas in this regard.

Table 2.2 Possible cybersecurity technology areas for knowledge transfer with Japanese counterparts

- Cybersecurity technology based on AI (artificial intelligence)
- Cybersecurity technology for car connectivity
- Cybersecurity technology for IIoT (Industrial Internet of Things)
- Cybersecurity technology for critical infrastructure
- Cybersecurity education and training
- Cybersecurity information sharing platform
- Security technology for factory inspection by drone

[102] The press release as of 16th October 2015 published by MOFA of the Japanese government: http://www.mofa.go.jp/press/release/press4e_000892.html.

2.5 Knowledge transfer opportunities in the area of AI-based cybersecurity technology

Cybersecurity is one of the vital application domains in IT for AI (artificial intelligence). There are cases where Japanese companies have partnered with foreign AI-based cybersecurity tech ventures.

Table 2.3 Examples of collaboration between Japanese and foreign companies in the AI-based cybersecurity tech field

Darktrace (UK) / NESIC (Japan)	In 2017, NEC Networks & System Integration Corporation (NESIC) reached an agreement with Darktrace, a AI-based cybersecurity technology venture that is a spin-off from the University of Cambridge.[103] Darktrace's technology uses AI algorithms to automatically detect and take action against cyber-threats within all types of networks, including physical, cloud and virtualized networks, as well as IoT and industrial control systems.
Cybereason (USA) / SoftBank (Japan)	In 2016, SoftBank invested USD 100 million into the US-based cybersecurity start-up Cybereason. Cybereason specializes in end-point detection and response to digital security breaches.[104] Cybereason's technology is based on the AI-based algorithm that does behavioral analytics on every single digital action and interaction happening within a company's network. It processes information in real-time to provide visibility into the security landscape within the network and pulls together related elements of a cyberattack. This way IT specialists in companies can detect and proactively respond against threats. Cybereason has been named to the 2018 AI 100, which ranks the 100 most promising artificial intelligence companies in the world.

[103] The press release as of 20th July 2017 published by Darktrace: https://www.darktrace.com/press/2017/182/.

[104] The press release as of 22nd June 2017 published by SoftBank (Japanese): https://www.softbank.jp/corp/group/sbm/news/press/2017/20170622_01/.

2.6 Knowledge transfer opportunities in the area of cybersecurity technology for car connectivity

Car connectivity is a key driver for Society 5.0 (see Section 1 "Automated Driving Technology" of this report). However, the development of car connectivity raises questions as to how data privacy and cyber security will be addressed. In fact, cars equipped with devices connected to the Internet can be hacked and controlled remotely through smartphones, according to an experiment conducted in 2015 by an associate professor at Hiroshima City University's Graduate School of Information Sciences in Japan.[105]

In this regard, there are cases of international alliance between Japanese and foreign companies or of foreign companies approaching the Japanese market in the field of cybersecurity technology for car connectivity. Examples in this regard are shown in the table below.

Table 2.4 Examples of alliance opportunities in Japan in the field of cybersecurity technology for car connectivity

Argus Cyber Security (Israel) / SBI (Japan)	In 2015, SBI Group invested, together with five other investors, in Argus Cyber Security, an Israel-based venture which is a pioneer in automotive cyber security.[106] Argus' technology solutions prevent a vehicle's critical systems from being hacked and are seamlessly integrated into any vehicle production line, with no architecture changes needed. Car manufacturers using the Argus Cyber Dashboard gain situational awareness to the cyber health status of their vehicles, receive pin-point alerts and respond in real-time to cyberattacks.
NNG (Hungary)	NNG, a Hungary-based navigation solution company, is now vigorously approaching the Japanese cybersecurity market for car connectivity. NNG, which purchased Israeli cybersecurity venture Arilou in 2016, provides a cybersecurity system to prevent cyber-threats to cars. The system

[105] The website of Dr. Hiroyuki Inoue at Graduate School of Information Sciences of Hiroshima City University (Japanese): http://www.inet.info.hiroshima-cu.ac.jp/hinoue/.

[106] The press release as of 24th September 2015 published by SBI Group (Japanese): http://www.sbigroup.co.jp/news/2015/0924_9704.html.

	called Parallel Intrusion Prevention System (PIPS) filters out any malicious commands sent to your car using a smart checking mechanism.

On the other hand, several Japanese electronics companies are engaging in the R&D activity for the development of cybersecurity technology for car connectivity. The table below shows three examples in this regard.

Table 2.5 Examples of Japanese electronic companies' R&D initiatives in the field of cybersecurity technology for car connectivity

Panasonic (Japan)	Panasonic has developed automotive intrusion detection and prevention systems against cyber attacks.[107] The systems can detect intrusions of attacks from the Internet at an early stage, and additionally detects intrusions to the in-vehicle network as a second step. In addition to the widely used CAN, the systems are also compatible with Ethernet, which is expected to spread in the future as an in-vehicle network, and enables comprehensive detections of intrusions to the entire vehicle.
Fujitsu (Japan) / Yokohama National University (Japan)	A team including researchers from Fujitsu Laboratories and Yokohama National University professor Tsutomu Matsumoto[108] have worked together to co-develop technology to notify the driver and encrypt signals when an attack is detected, allowing legitimate signals to be transmitted and the vehicle to stop safely.
Mitsubishi Electric (Japan)/ Ritsumeikan University (Japan)	Professor Takeshi Fujino at Ritsumeikan University[109] and Mitsubishi Electric have jointly developed security technology that prevents the theft of digital keys for decrypting automotive network signals.

[107] The press release as of 10th October 2017 published by Panasonic: http://news.panasonic.com/global/press/data/2017/10/en171010-3/en171010-3.html.

[108] The website of Matsumoto Laboratory at Yokohama National University (Japanese): http://www-mlab.jks.ynu.ac.jp/.

[109] The website of Fujino Laboratory at Ritsumeikan University: http://research-db.ritsumei.ac.jp/Profiles/28/0002739/prof_e.html.

In 2017, major automakers including Toyota, Nissan, Honda, Mazda, and Fuji Heavy Industries and several parts suppliers set up a working group within the Japan Automobile Manufacturers Association with the aim of sharing information about cybersecurity against cyberattacks on connected cars.[110]

2.7 Knowledge transfer opportunities in the area of cybersecurity technology for IIoT (Industrial Internet of Things)

Cybersecurity technology for IIoT (Industrial Internet of Things) in manufacturing factories may be a vital area in which European cybersecurity ventures conduct knowledge transfer with Japanese counterparts. The table below shows an example of knowledge transfer from a US-based firm to a large Japanese electric company.

Table 2.6 Example of alliance between Japanese and foreign companies in the field of cybersecurity technology for IIoT

Bayshore Networks (US)/ Yokogawa Electric Corporation (Japan)	In this regard, in 2016, Yokogawa Electric Corporation invested USD 900,000 in Bayshore Networks, a U.S. technology innovator that is developing cybersecurity software for the Industrial IoT (IIoT), which is a crucial component in Yokogawa's IIoT architecture research and development efforts.[111] With this investment, Yokogawa supports the development of Bayshore Networks' IIoT security technology, and utilize the technology to expand its cybersecurity solutions lineup for plant operators.

[110] *Tokyo Shimbum*, the online article as of 1st April 2017 (Japanese): http://www.tokyo-np.co.jp/article/economics/list/201704/CK2017040102000253.html.

[111] The press release as of 4th November 2016 published by Yokogawa: https://www.yokogawa.com/us/news/press-releases/2016/yokogawa-makes-strategic-equity-investment-in-bayshore-networks-an-emerging-us-based-leader-in-advanced-iiot-security/.

2.8 Knowledge transfer opportunities in the area of cybersecurity technology for critical social infrastructure

As the world becomes more connected, critical infrastructure will be even more exposed to cyberattack. The development and installation of cybersecurity technologies for critical social infrastructure is a vital element of Japan's strategy for the realization of "Society 5.0" as well as for the success of the Tokyo Olympics 2020. For this reason, since 2013, the Council for Science, Technology and Innovation (CSTI) within the Cabinet Office has been promoting a national flagship R&D project for cybersecurity technology development for critical infrastructure, as a SIP (Cross-ministerial Strategic Innovation Promotion Program) titled "Cyber-Security for Critical Infrastructure."[112]

In this connection, the Estonian blockchain firm Guardtime has received some media coverage in Japan in relation to its vital role in the "E-Estonia" initiative (see Section 4.11 below). And, that firm's cybersecurity services for critical infrastructure in the UK may also capture keen attention in Japan.

Table 2.7 Example of foreign cybersecurity companies for critical infrastructure that attract attention in Japan	
Guardtime (headquartered in the Netherlands/ founded in Estonia)	Guardtime, which was founded in 2007 in Estonia and is now headquartered in Amsterdam. Guardtime is now in partnership with the UK Future Cities Catapult, which is the UK government's center for urban infrastructure innovation.[113] Under the partnership, Guardtime provides its blockchain-based cybersecurity mechanisms for the UK Future Cities Catapult.[114] This partnership is expected to address the concerns highlighted in a recent report by Chatham House, a UK think-tank, that mentioned cybersecurity concerns around nuclear power plants, with the industry harboring a "culture of denial"

[112] The brochure published by the Cabinet Office of the Japanese government regarding the SIP on cybsersecurity for critical infrastructure: http://www8.cao.go.jp/cstp/panhu/sip_english/cybersecurity.pdf.

[113] The website of Future Cities Catapult: futurecities.catapult.org.uk.

[114] The press release as of 17th December 2015 published by Guardtime: http://www.marketwired.com/press-release/guardtime-future-cities-catapult-partner-develop-blockchain-based-cybersecurity-uk-critical-2082851.htm.

	about the risk of cyber hacking with many failing to protect themselves against digital attacks.

2.9 Knowledge transfer opportunities in the area of cyber education and training

As mentioned in Cybersecurity Management Guidelines published by METI and IPA (Section 2.2 above), education in the business community on cybersecurity is a vital policy target for the Japanese government. This is all the more important, in view of the fact that, by the year 2020, there would be a shortage of 193,000 people in the cybersecurity field in Japan, according to a report issued by METI in 2016.[115]

In this respect, government effort in training cybersecurity personnel has gained momentum. For example, the National Center of Incident Readiness and Strategy for Cybersecurity (NISC) organized the cyber defense training program called CYDER (Cyber Defense Exercise with Recurrence) from 2013 to 2017. In April 2017, METI and IPA launched the Industrial Cybersecurity Center of Excellence to train 100 business executives from critical infrastructure companies every year.[116]

On the other hand, Japanese companies are also paying attention to cybersecurity education programs offered by foreign companies. For example, Dai Nippon Printing (DNP) and Hitachi are now in partnership agreement with Israeli ventures for cybersecurity training, as mentioned in the table below.

Table 2.8 Israeli companies that offer cybersecurity education programs in the Japanese market	
Israel Aerospace Industries (Israel) / Dai Nippon Printing	In 2015, Dai Nippon Printing (DNP), one of Japan's largest printing companies, reached a partnership agreement with Israel Aerospace

[115] METI, 2016, *Recent Trends and Future Estimates Concerning IT Human Resources* (Japanese). Available at: http://www.meti.go.jp/press/2016/06/20160610002/20160610002.html.

[116] The brochure of IPA's Industrial Cyber Security Center of Excellenct: https://www.ipa.go.jp/files/000062153.pdf.

(Japan) / Deloitte Tohmatsu Risk Services (Japan)	Industries (IAI), Israel's aerospace and defense company.[117] IAI's cybersecurity education program named TAME Range allows a realistic cyber warfare training environment to improve the cyber awareness and readiness of cyber defenders. TAME Range provides its users with authentic, hands-on training in a controlled environment, using real-world cyber threats. The TAME Range curriculum covers all aspects of cyber warfare, including threat identification, incident management, mitigation, and forensics. It provides training on the tools and techniques that are under a team's command when a real attack actually occurs. Under the partnership agreement, DNP is the distribute of TAME Range to Japanese corporate customers. In 2017, Deloitte Tohmatsu Risk Services reached an agreement with DNP to promote the expansion of the TAME Range program in the Japanese market.[118]
CyberGym (Israel) / Hitachi (Japan)	In 2017, Hitachi and CyberGym, a cutting-edge cybersecurity tech company in Israel, have started co-promoting an advanced hands-on cybersecurity training and defense training facility.[119] CyberGym's training is conducted in a staged technological environment which is identical to the one in which the organization operates. This is an approach that enables organizations to practice real-world cyber-attack scenarios that are as close as possible to the real thing. As part of the agreement, a hands-on cyber security training and defense facility was established at Hitachi's complex in Japan. CyberGym trains Hitachi's employees who will operate the facility.

[117] The press release as of 26th August 2015 published by IAI: http://www.iai.co.il/2013/32981-46483-en/MediaRoom.aspx.

[118] The press release as of 28th November 2017 published by Deloitte (Japanese): https://www2.deloitte.com/content/dam/Deloitte/jp/Documents/about-deloitte/news-releases/jp-nr-nr20171128.pdf.

[119] The press release as of 27th June 2017 published by Hitachi (Japanese): https://www.medianet.com.au/releases/136390/.

	 Photo from Hitachi's website.[120]

In the cybersecurity education field, contests over hacking skills are gaining popularity in Japan. One good example is the Security Contest (SECCON), Japan's largest computer security contest, which is supported by the government and many Japanese IT companies.[121] The SECCON 2016 attracted a total of 4,349 participants from 99 countries through various qualifying rounds in their countries. Participating teams compete for points by hacking virtual servers to discover particular keywords, and can also intervene to stop their rivals' cyberattacks. The primary objective of the event is to foster the cybersecurity intelligence around the world.

2.10 Knowledge transfer opportunities in the area of cybersecurity information sharing platform

In the global cybersecurity market, there is a strong need in the Japanese government, industry and academia for an international platform for cyber-security information sharing and collaborative cyber-security intelligence analysis, as can be seen in the alliance between Surevine in the UK and Hitachi Systems in Japan.

Table 2.9 Example of cybersecurity information sharing platform	
Surevine (UK)/ Hitachi Systems (Japan)	In 2017, Hitachi Systems, a subordinate company of Hitachi, started a collaboration project with a British company named Surevine.[122] The purpose of this agreement is for Hitachi Systems to provide

[120] Ibid.

[121] The website of SECCON: https://2017.seccon.jp/.

[122] The press release as of 27th January 2017 published by Hitachi Systems (Japanese): https://www.hitachi-systems.com/news/2017/20170127.html.

	cybersecurity technology information services to Japanese clients based on Surevine's cyber-security information sharing platform named Threatvine, which is designed for secure cross-organizational collaboration and collaborative intelligence analysis. Uniting critical national infrastructure, law enforcement and academia, Threatvine moves beyond cyber-security information sharing to collaborative cyber-security intelligence analysis. In the UK, more than 2,000 entities including government agencies and companies have utilized the Threatvine platform for information sharing in the cybersecurity field.

2.11 Knowledge transfer opportunities in the area of security technology for factory inspection by drone

Security technology for factory inspection by drone is also gaining attention in Japan, although it may not be a type of *cyber*security technology.

Table 2.10 Example of security technology for factory inspection by drone

Sky-Futures (UK)/ Mitsui & Co. (Japan)	Whilst on the UK trade mission to Japan led by Prime Minister Theresa May in 2017, UK-based venture Sky-Futures confirmed a $4m investment and partnership with Japan-based Mitsui & Co., one of Japan's largest trading, investment and service enterprises. Sky-Futures is a specialist provider of drone-based inspection technology that enables tracking and monitoring of highly complex infrastructure, automatically detecting defects and saving precious engineering time.

2.12 Business matching events for cybersecurity technology in Japan

Now there are a growing number of trade shows and exhibitions for foreign companies to showcase their cutting-edge cybersecurity technologies to Japanese customers. One particular

example is Cybertech Tokyo.[123] Since 2014, Cybertech has served as one of the largest trade show events in the field of cybersecurity technology around the globe. Cybertech Tokyo, Cybertech's first event in Japan, took place on November 30, 2017 under the sponsorship of the Japanese government. Other examples include CEATEC Japan,[124] Japan IT Week,[125] and Risk Control in Tokyo.[126]

2.13 Knowledge transfer/sharing opportunities with Japanese universities and research institutes

Many Japanese universities have actively engaged in the R&D regarding cybersecurity. The Information Processing Society of Japan (IPS), Japan's largest academic society about information technology that currently consists of about 18,000 researchers and 210 corporate members, deals with a variety of cybersecurity issues.[127]

Table 2.11 Examples of major Japanese universities and institutes in the field of cybersecurity

- The University of Tokyo
  - SISOC-TOKYO: http://sisoc-tokyo.iii.u-tokyo.ac.jp/en/greeting/
- Tokyo Institute of Technology (Tokyo Tech)
  - Tokyo Tech Cybersecurity: http://www.cybersecurity.titech.ac.jp/
  - Tokyo Tech is now in partnership with Nomura Research Institute (NRI), one of Japan's largest IT consulting firms, for the co-development of cybersecurity technologies.[128]
- University of Tsukuba
  - Department of Risk Engineering: http://www.risk.tsukuba.ac.jp/index_eng.html
  - Lab of Cryptography and Information Security: http://www.cipher.risk.tsukuba.ac.jp/
  - Machine Learning/Data Mining Lab, Computer Science Department: http://www.mdl.cs.tsukuba.ac.jp/introduction_j.html

[123] The website of Cybertech Tokyo: http://tokyo.cybertechconference.com/.
[124] The website of CEATEC Japan: http://www.ceatec.com/ja/application/.
[125] The website of Japan IT Week: http://www.ist-expo.jp/.
[126] The website of Risk Control in Tokyo: : http://www.kikikanri.biz/.
[127] The website of IPS: http://www.ipsj.or.jp/english/index.html.
[128] The press release as of 5th October 2016 published by NRI: https://www.nri.com/global/news/2016/160510_1.aspx.

- Keio University
  - International Cyber Security Center of Excellence (INCS-CoE): https://www.keio.ac.jp/en/press-releases/files/2016/11/1/161101_1.pdf
  - INCS-CoE is an international university consortium consisting of universities in the UK, the US, and Japan. From the UK, University of Oxford, University of Cambridge, Imperial College London, and University College London have participated in the consortium. INCS-CoE will focus on the R&D regarding cybersecurity systems relating to IoT, AI, and critical Infrastructure, among others.
- Kyushu University
  - Cybersecurity Center: https://cs.kyushu-u.ac.jp/en/
- National Institute of Information and Communications Technology
  - Cybersecurity Lab: http://www.nict.go.jp/en/cyber/index.html
- National Institute of Informatics: http://www.nii.ac.jp/en/
- Institute of Information Security: http://www.iisec.ac.jp/
- National Institute of Advanced Industrial Science and Technology (AIST)
  - Information Technology Research Institute: https://www.itri.aist.go.jp/en/

2.14 Knowledge transfer/sharing opportunities with Japanese industry associations in the cybersecurity field

The following are a list of major Japanese industry associations in the cybersecurity field.

Table 2.12 List of major Japanese industry associations in the cybersecurity field

- Japan Network Security Association: http://www.jnsa.org/
- Japan Computer Emergency Response Team (JPCERT): http://www.jpcert.or.jp/
- Japan Smartphone Security Association: https://www.jssec.org/
- ICT-ISAC Japan: https://www.ict-isac.jp/public/member.html
- Japan Cybercrime Control Center: https://www.jc3.or.jp/
- The Center for Financial Industry Information Systems: https://www.fisc.or.jp/
- Japan Card Data Security Consortium: http://www.jcdsc.org/

3. Fintech (Financial Technology)

3.1 The growing fintech market in Japan

Companies relating to financial technology or "fintech" have momentum in the global market. According to Accenture, the value of global fintech investment in 2015 grew by 75 percent to USD 22.3 billion, and global investment in fintech venture companies in the first quarter of 2016 reached USD 5.3 billion, a 67 percent increase over the same period last year.[129]

In line with this global trend, Japan is experiencing a fintech boom. According to Accenture, the investment in fintech companies in the country rose to USD 65 million in 2015, a 20 percent increase from the previous year,[130] and the investment in fintech ventures in Japan amounted to USD154 million from 14 deals in 2016, more than double the previous year's USD 65 million.[131]

Japanese megabanks and other financial institutions are on the move towards collaborating with and funding fintech startups not only in Japan but also in foreign countries, including EU member states, as will be described below.

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[129] Accenture, 2016, *Fintech and the evolving landscape: landing points for the industry*. Available at: https://newsroom.accenture.com/news/global-fintech-investment-growth-continues-in-2016-driven-by-europe-and-asia-accenture-study-finds.htm.

[130] Accenture, 2016, *The booming fintech market: suggestions for Japan* (Japanese). Available at: https://www.accenture.com/jp-ja/~/media/Accenture/jp-ja/Documents/DotCom/Accenture-Fintech-Evolving-Landscape-jp.pdf.

[131] Source: Reuters' news article titled "Global fintech investment up 10 pct in 2016, driven by China – Accenture" as of 28th February 2017. Available at: https://www.reuters.com/article/japan-fintech/global-fintech-investment-up-10-pct-in-2016-driven-by-china-accenture-idUSL3N1GD1WM.

3.2 Government initiatives to promote fintech business in Japan

Legislative initiatives

Behind this fintech momentum in Japan, the Japanese government made two new laws in 2016 to boost the development of fintech business and industry in Japan, as described in the table below. Both of the laws took effect in 2017.

Table 3.1 The 2016 legislation to promote fintech business in Japan

To free up the flow of capital from banks into fintech ventures	The first one is the new regulation created by revising the Banking Law of Japan, which previously limited the amount of investment by Japanese banks in fintech companies, or prevented them from owning more than 5 per cent of a technology company. Under the new regulation, banks and bank holding companies are now allowed to buy stakes of up to 100 percent, with the approval of the Financial Services Agency of the Japanese government, in fintech companies, as long as the purpose of their investment is to apply information technology to their financial services.
The regulation regarding virtual currencies	The other one is a new virtual currency regulation that defines virtual currencies such as bitcoin to be a legal form of payment fulfilling the functions of currency, aiming at promoting the usage of virtual currency as a tool for money transactions and the development of blockchain technology for it. The Japanese government describes the new regulation as the first of its kind in the world. In addition, the Japanese government ended sales-tax collection on purchases of virtual currencies in the spring of 2017. (Japan was the only country among the Group of Seven leading industrial economies that taxes the purchase of virtual currencies.)

In addition to the 2016 legislation, another bill to amend Japan's Banking Act was also passed in the Diet in Tokyo in 2017.[132] One of the things defined in this new legislation, which will be implemented in 2018, is to oblige financial institutions to make their efforts to develop a system

[132] The explanagory materials regarding the amended Banking Act (in Japanese) are downloadable from the website of the Financial Services Agency of the Japanese government: http://www.fsa.go.jp/common/diet/193/01/setsumei.pdf.

pertaining to the introduction of an open API (Application Programming Interface). API means a program for a third party other than a bank to utilize the function of the banking system by connecting into the system. Open API effectively means that a bank provides its API with the providers and consents to their access to the bank system. This legislation will promote the development of various types of fintech business using open API of banks (see Section 3.7).

Fintech Support Desk run by FSA

While taking initiative in formulating the above-mentioned new regulations, since 2015, the Financial Services Agency (FSA) of the Japanese government has run the Fintech Support Desk, which is a one-stop contact point where fintech-related companies can receive consultation on the legal issues involved with new fintech businesses in Japan.[133] By the end of June of 2016, that function within FSA received 91 inquiries in total from various fintech-related entities regarding the above-mentioned new regulations and so on.

The Bank of Japan

Furthermore, while being aware of potential fintech-related risks such as cyber attacks, the Bank of Japan (BOJ), the central bank of Japan, has now committed to leading research and analysis to promote fintech in Japan and may apply fintech to its operations in the future, given its growing influence on global payments, settlements and financial services, and given its potential impact on central banking.[134] In fact, in April 2016, BOJ established the FinTech Center, an in-house research section which functions to serve as a point of contact between the BOJ and fintech-related companies and to explore how to support the private sector in promoting Japan's booming fintech market.[135]

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[133] The announcement as of 14th December 2015 on the website of FSA regarding the establishment of the FinTech Desk (Japanese). Available at: http://www.fsa.go.jp/news/27/sonota/20151214-2.html.

[134] The remarks made by BOJ's Governor Haruhiko Kuroda on the FinTech Forum as of August 23, 2016. Available at: https://www.boj.or.jp/en/announcements/press/koen_2016/ko160823a.htm/.

[135] The announcement as of 1st April 2016 on the website of BOJ regarding the establishment of the Fintech Center. Available at: https://www.boj.or.jp/en/announcements/release_2016/rel160401a.htm/.

3.3 Possible fintech areas for knowledge transfer with Japanese counterparts

Under the abovementioned circumstances, chances for EU entities in industry to establish alliance with key Japanese players in the fintech field are growing. The table below shows four examples of possible fintech areas in this regard.

Table 3.2 Possible fintech areas for knowledge transfer with Japanese counterparts

- Virtual-currency-based services for payment and money transfer
- Cashless and cardless payment systems based on biometric technology
- AI-based investment advisory services
- Cloud-computing-based cash management services

The number of fintech companies in Japan is still small from an international perspective, but a growing number of fintech venture companies in the country have now been delivering new financial products and services with their high-quality financial technologies by combining various information technologies.

When formulating technology collaboration strategies for Japanese counterparts, it is important for European fintech companies to identify what competitive advantages their technologies can generate against those of their rivals' technologies in the financial services market.

3.4 Knowledge transfer opportunities in the utilization of virtual currency for payment and money transfer

It has been said that the risk-averse mind-set of the general public that still show a strong preference to paying in cash over using credit cards, can be a large obstacle for the spread of disruptive fintech innovation in Japan.

On the other hand, Japan now has seven virtual currency exchanges and an estimated 50,000 or so bitcoin users. More than 2,500 stores now take payment in bitcoin, including restaurants, dentists and nail salons.

In this regard, there will be increasing opportunities for EU fintech ventures to ally with Japanese financial companies in the area of virtual-currency-based payment services for Japanese customers. The table below shows two examples of corporate alliances in this regard.

Table 3.3 Examples of knowledge transfer from European ventures to Japanese counterparts in the field of virtual-currency-based payment systems

Wirex (UK) / SBI (Japan)	In October 2017, the UK-based crypto-payments company Wirex formed a joint venture company with Japan-based fintech investing powerhouse SBI Holdings to launch a cryptocurrency payments card in Japan.[136] Wirex already offers a Visa-backed cryptocurrency debit card but the new joint venture, called SBI Wirex Asia, rolls out a Yen denominated option. In addition, the partners plan to move into other Asian markets.
nChain (UK) / SBI BITS (Japan)	In December 2017, nChain, a UK-based blockchain venture, and SBI BITS, a Japan-based financial technology provider company that is a wholly-owned subsidiary of SBI Holdings, announced a strategic partnership to collaborate on cryptocurrency growth initiatives, focused especially on the Bitcoin Cash network.[137] For their first collaborative project, SBI BITS and nChain will work together to develop stronger cryptocurrency security solutions for institutions and customers, in particular, a next-generation advanced secure wallet system.

The popularity of virtual currencies also comes from the fact that users can send virtual currencies to others in foreign countries at extremely low costs. Major financial institutions in Japan have paid great attention to the development of platforms for low-cost international

[136] The press release as of 20th October 2017 published by SBI Holdings (Japanese): http://www.sbigroup.co.jp/news/2017/1020_10846.html.

[137] The press release as of 7th December 2017 published by SBI Holdings (Japanese): http://www.sbigroup.co.jp/news/2017/1207_10907.html.

money transfers by using virtual currencies such as Bitcoin. What is behind this is the fact that, while wiring money internationally costs several thousand yen per transaction, users can send virtual currencies to others in foreign countries for much lower costs. Also, with a virtual currency platform, wiring money could also become available around the clock, instead of being confined to ATM hours. One of the main targets of those platforms is an increasing number of foreign tourists to Japan in anticipation of the coming 2020 Tokyo Olympics.

Japanese financial companies are keen to collaborate with foreign companies to promote blockchain-based virtual currency schemes for international money transfer. Examples of collaborative schemes between Japanese and European companies in this respect are as follows.

Table 3.4 Examples of knowledge transfer from European ventures to Japanese counterparts in the field of virtual-based-schemes for international money transfer

Azimo (UK) / Rakuten (Japan)	In May 2016, Azimo, a U.K. online money transfer business aimed at making it cheaper to send cash around the world, raised USD 15 million led by Japanese e-commerce giant Rakuten as the start-up looks to expand its presence in Asia.[138] Azimo allows users to transfer money around the world in over 80 currencies at a rate it claims is cheaper than some banks and other established rivals. The receiver can get that money through different methods from a simple bank transfer to picking up physical cash or having it delivered to their mobile wallet, banking services that can be done via simple text messages.
TransferWise (headquartered in the UK, founded in Estonia) / Gaiax (Japan)	In 2017, TransferWise Japan, a subsidiary of Estonia-oriented fintech venture TransferWise, which is now headquartered in London, entered into a partnership agreement with Gaiax, a Japanese internet business company, so that the combination of TransferWise's technology for international money transfer and Gaiax's technology called Trust Dock, which is a blockchain-based platform mechanism that manages the

[138] The press release as of 5th May 2016 published by Azimo: https://azimo.com/en/mediapost/azimo-announces-strategic-investment-rakuten-accelerate-asian-expansion.

	personal identification of customers, can create new services for international money transfer.[139]

On the other hand, Mizuho Financial Group and the SBI Holdings group are jointly promoting a pilot project to develop an international money transfer platform using Ripple.[140] The two companies are promoting this service via a blockchain-technology-related corporate consortium, consisting of more than 70 of the world biggest financial institutions worldwide.[141] This joint project is expected to address the most common negative points in cross-border payments: high costs and settlement delay.

Table 3.5 Ripple and Ethereum

Bitcoin is not the only cryptocurrency. The number of cryptocurrencies available over the internet as of January 2018 is over 1384, and it is still growing. By market capitalization, Bitcoin is currently the largest blockchain network, followed by Ethereum and Ripple.

Ripple is the third largest cryptocurrency platform, and is used for real-time currency exchange and remittance managed by Ripple, a US fintech that uses blockchain technology for payments and settlement. Currently implemented by a growing number of global financial companies, including UniCredit, UBS or Santander, the Ripple protocol has been increasingly adopted by banks and payment networks over the world as reliable settlement infrastructure technology.

Ethereum is the second largest cryptocurrency platform and is often regarded as Bitcoin's main rival. However, the two differ in purpose. While Bitcoin is created as an alternative to ordinary money and is therefore a medium of payment transaction and store of value, Ethereum is developed as a platform to facilitate peer-to-peer contracts and applications via its own currency vehicle.

[139] The press release as of 2nd August 2017 published by Gaiax (Japanese): http://www.gaiax.co.jp/blog/press2017-08-02/.

[140] The press release as of 18th July 2016 published by Ripple: https://ripple.com/insights/mizuho-pilot-ripple-cross-border-payments/.

[141] This consortium is led by R3 (R3CEV LLC), which is a blockchain technology company in USA. See the website of R3: https://r3cev.com/.

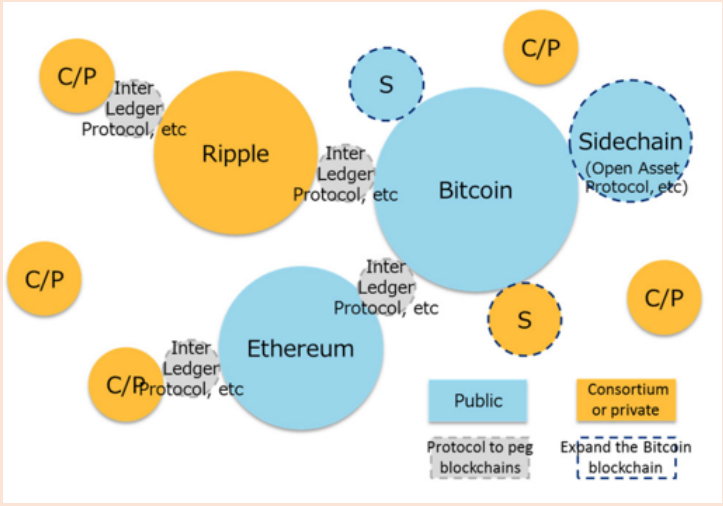

Diagram from METI's report "Survey on Blockchain Technologies and Related Services, 2015.[142]

Mitsubishi UFJ Financial Group (MUFG), the largest financial company in Japan and the fourth largest bank in the world, now plans to launch its own homemade digital currency MUFG coin in 2018.[143] Based on this digital currency system, MUFG will allow users to conduct instant person-to-person transactions with lower fees. MUFG also plans to peg one MUFG coin to one Japanese yen in order to maintain people's confidence in this new cryptocurrency system.

In parallel with the growing popularity of virtual currencies such as Bitcoin in Japan, several virtual currency exchange platforms have appeared in the country. Among them, Bitflyer is currently the largest bitcoin exchange in the country, having been capitalized at JPY 3.9 billion so far. In 2017, Mizuho Capital, SMBC Venture Capital and Dai-ichi Life Insurance, three Japanese financial companies, together invested USD 1.75 million in BitFlyer. On the other hand, in January 2018, Tokyo-based cryptocurrency exchange Coincheck revealed that it received massive cybserattacks, which resulted in a loss of 523 million NEM coins,[144] worth approximately USD 534 million, to hackers. This security breach is considered to have been

[142] Available at: http://www.meti.go.jp/english/press/2016/0531_01.html.

[143] *Mainichi Shimbun*, the online news article as of 14th January 2018 (Japanese). Available at: https://mainichi.jp/articles/20180114/k00/00m/020/098000c.

[144] NEM is a type of peer-to-peer cryptocurrency and blockchain platform that was started in 2014. The NEM blockchain software is used in a commercial blockchain called Mijin, which is being tested by financial institutions and private companies in Japan and internationally. See the website of NEM: https://nem.io/.

caused by the lack of strong security measures of Coincheck.[145] The Coincheck theft is likely to push policymakers to enforce stricter security requirements at cryptocurrency exchanges.

3.5 Knowledge transfer opportunities in the area of cashless and cardless payment systems based on biometric technology

New "cashless and cardless" payment systems in which consumers are able to carry out transactions with nothing more than a touch or wave are now appearing in Japan one after another. In this regard, opportunities for European biometrics ventures to conduct knowledge transfer with Japanese counterparts are increasing, as shown in the table below as an example.

Table 3.6 Example of knowledge transfer from European biometrics ventures to Japanese counterparts

Danon (Ireland)/ NTT Data (Japan)	In September 2016, Danon, an Irish biometrics company, signed an agreement with Sumitomo Mitsui Financial Group, one of Japan's megabanks, and NTT Data, one of Japan's largest IT infrastructure companies, in order to create services offering individual identification platforms that use several different types of biometrics based on Danon's technology for online payments.[146]

On the other hand, there are Japanese companies that have engaged in the development of cutting-edge biometric technology for fintech services, as shown in the table below. They can be good partners for or strong rivals against EU fintech ventures in this field. So, when formulating technology collaboration strategies for Japanese counterparts in this field, it is of vital importance for European fintech companies to identify what competitive advantages their technologies can generate in comparison with potential Japanese partners or rivals.

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[145] Coincheck will return about JPY 46.3 billion (USD 425 million) of the virtual money it lost to hackers in this cyberattack incident, according to its press release as of 28th January 2018 (Japanese): http://corporate.coincheck.com/2018/01/28/30.html.

[146] The press release as of 16th September 2016 published by Danon: https://www.daon.com/newsroom/press-releases/339-smfg-and-smbc-sign-agreement-with-ntt-data-and-daon-inc-start-full-fledged-consideration-of-individual-identification-platform-using-various-types-of-biometrics.

Table 3.7 Japanese companies' initiative in the field of biometric-based fintech for payment systems	
Hitachi (Japan)/ Barclays (UK)	Barclays, one of UK megabanks, has been in partnership, since 2014, with Hitachi Europe, a subsidiary of Hitachi, one of Japan's electronic giants, to fight against fraud with the launch of the Barclays Biometric Reader, developed with Hitachi's finger vein authentication technology.[147] Hitachi's technology in this respect is recognized as one of the most secure biometrics in the market.
JCB (Japan)/ Fujitsu (Japan)	JCB, one of Japan's major credit card companies, is developing a new payment system using the palm vein authentication technology of Fujitsu, one of Japan's electronic giants. This service will link vein patterns with credit card information, allowing customers to make fast and secure payments simply by waving their palms over a scanner.[148] Fujitsu has focused on palms because the networks of blood vessels are more complex than in the fingers, which helps to ensure stable authentication. According to Fujitsu, palm vein authentication was extremely accurate, with a false acceptance rate of less than 0.00008% and a false rejection rate of only 0.01%, resulting in highly reliable security.
Nets (Denmark)/ JCB (Japan)	JCB is in partnership with Nets, a Danish mobile payment service company, for the Danish company to use JCB's contactless technology in the Danish payment services market.[149]
Liquid (Japan)	Liquid is a biometric-based payment technology startup that was originally born out of the Docomo Venture Village and has been financially supported by the I-Challenge program promoted by the Ministry of Internal Affairs and Communications.[150] When using the service provided by Liquid, all a customer needs to do to pay at shops or

[147] The press release as of 5th September 2017 published by Hitachi: http://www.hitachi.eu/en/press/barclays-first-uk-launch-new-biometric-reader-customers.

[148] The press release as of 7th October 2015 published by Fujitsu: http://www.fujitsu.com/global/about/resources/news/press-releases/2015/1007-01.html.

[149] The press release as of 19th April 2016 published by Nets: https://www.nets.eu/Media-and-press/news/Pages/Nets-and-JCB-partner-to-drive-mobile-payments-in-Denmark.aspx.

[150] The website of the Ministry of Internal Affairs and Communications regarding the basic framework of the I-Challenge program (Japanese). Available at: http://www.soumu.go.jp/menu_seisaku/ictseisaku/ictR-D/ichallenge/.

	restaurants is to put his or her thumb on a small fingerprint sensor machine pre-installed in those places. Pre-registered biometric data, bank balances and other information are encrypted and stored securely in the cloud computing system, rather than at shops and restaurants. This Liquid payment system is gaining popularity in use at public bathhouses, beaches and other places where people are typically concerned about their wallets being stolen or lost.[151]
Bank of Japan/ Yokohama National University (Japan)	The Center for Information Technology Studies within the Bank of Japan[152] has engaged, in collaboration with the Research Center for Information and Physical Security within Yokohama National University, in the R&D regarding biometrics technology in the context of fintech business.

3.6 Knowledge transfer opportunities in the area of AI-based fintech

AI-based investment advisory services

The technology for AI-based investment advisory services is a possible area for cutting-edge AI ventures in the EU to conduct knowledge transfer with Japanese financial entities. In this regard, two French ventures developing AI-based fintech, namely Quantcube Technology and Shift Technology, have participated in the venture acceleration program called Fintech Business Camp Tokyo promoted by the Tokyo Metropolitan Government. (For the information on Fintech Business Camp Tokyo, see Section 3.9 below.)

[151] Since October 2015, Liquid has promoted a test run at Huis Ten Bosch, a theme park in Sasebo, Nagasaki Prefecture of Japan, which draws a few million visitors a year, including plenty of foreign tourists. Visitors can register their biometric data at the entrance and other points. They can then use the Liquid Pay system at the park's restaurants and souvenir shops.

[152] The website of Center for Information Technology Studies within the Bank of Japan: http://www.imes.boj.or.jp/citecs/about.html.

Table 3.8 Two European fintech ventures in FinTech Business Camp Tokyo	
Quantcube Technology (France)	Provides service which utilizes various big data and AI to predict and analyze economic matters (e.g. economic growth rates, stock prices, etc.), and proposes investment products based on these prediction results.
Shift Technology (France)	Shift Technology utilizes AI technology to provide services to help insurance companies recognize fraud cases. AI automates the insurance fraud detection process.

Several Japanese companies have been offering investment advisory services based on AI technology. Examples of Japanese companies in this regard include Alpaca and Money Design, as mentioned in the table below.

Table 3.9 Examples of AI-based investment advisory services in Japan	
Alpaca (Japan) - Capitalico	Since March 2016, Alpaca, a leading Japanese startup in the field of AI and fintech, has provided the world's first deep-learning-based application called Capitalico, which enables traders to build their customized trade notifications and automated trading algorithms through highlighting their winning entry patterns. Capitalico is currently available as an iPhone application.
Money Design (Japan) - THEO	A fintech venture named Money Design provides a similar kind of "robo-adviser" or online-based advisory services named "THEO" for investment and asset management. Based on its database of user information, THEO offers customers a diversified portfolio consisting of 30 to 40 ETFs or exchange-traded funds, which are securities that track indexes, such as the Nikkei 225 and NASDAQ 100.

AI-based fintech for credit risk evaluation

At the same time, an increasing number of Japanese financial companies have started to adopt an AI-based system for credit risk evaluation. For example, Mizuho Bank has tested new ways of credit risk evaluation and management by using IBM Watson's cognitive technology to

analyze a wide range of data sources for credit risk evaluation and identifying possible financial criminals including terrorists sneaking into the customer base.[153]

In 2017, a consumer lender owned by Mizuho Bank and SoftBank launched a loan service that uses AI to assess applicants' repayment ability, targeting young customers via easier access to borrowing.[154] In 2018, Mizuho Financial Group announced its plan to start an AI-based credit risk evaluation service for small and medium-sized corporate customers.[155]

On the other hand, in 2018, Japanese financial services group Orix invested JPY 6.4 billion in Wecash, a rapidly growing Chinese startup that uses big data and AI to rate consumer credit.[156] Wecash have provided solutions to over 50 financial institutions and expanded its presence into Indonesia, Singapore, Brazil and the US as well as other countries and regions worldwide.

3.7 Knowledge transfer opportunities in the area of cloud-computing-based cash management services

One field of fintech business that has gained much attention in Japan is the cloud-computing-based services for cash management activities. There are several Japanese companies that provide services in this field, and foreign companies may enter this market if they have competitive advantages in their technologies over Japanese competitors. Three Japanese companies are particularly strong in this market:

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153 *Nikkei Shimbun*, the online article as of 24th August 2017 (Japanese). Available at: https://www.nikkei.com/article/DGXLRSP454875_U7A820C1000000/.

154 The press release as of 25th September 2017 published by SoftBank (Japanese): https://www.softbank.jp/corp/group/sbm/news/press/2017/20170925_01/.

155 *Mainichi Shimbun*, the online article as of 27th December 2017 (Japanese): https://mainichi.jp/articles/20171227/k00/00m/020/169000c.

156 *Nikkei Shimbun*, the online article as of 2nd March 2018 (Japanese). Available at: https://www.nikkei.com/article/DGKKZO27559220R00C18A3EE9000/.

Table 3.10 Examples of cloud-computing-based cash management services in Japan
• **Money Forward (Japan)**: https://moneyforward.com/ • **Freee (Japan)**: https://www.freee.co.jp/ • **Zaim (Japan)**: https://zaim.net/

Through the services provided by Money Forward, individual or corporate customers can gain access, based on the linkage between their own financial accounts (banks, credit cards, securities, etc.) and their Money Forward accounts, to the one-stop-shop online services that enable them not only to easily manage daily expenses, but also to do such things as accounting, payroll, payment collection, expense reporting, as well as to send invoices, see financial projections, and receive automatic asset management advice.

This Money Forward service is currently used by four million individuals and over 500,000 businesses in Japan. The company's free application for Android or iOS has been one of the most popular fintech service applications in the Google Play in the country. So far, the company has been capitalized at JPY 2.2 billion by banks and various other fintech-business-related companies. Startups such as Freee and Zaim are also providing similar services.

This type of businesses can operate on the basis of the "screen scraping" technology for the purpose of aggregating financial data from their customers' personal bank accounts. In order for this screen-scraping-based system to work, a customer needs to provide sensitive personal information such as login ID and password to those companies, which then use the provided personal information to log in to the customer's bank account in order to pull the most recent data from it. This "screen scraping" system can be vulnerable to cyber attacks if its cybersecurity mechanism is weak.

On the other hand, if banks open up their application programming interfaces (APIs) for the services provided by Money Forward, Freee and Zaim, customers can use those companies' services under safer and more convenient environment without the need to give those companies their banks' login ID and password.

For this reason, to drive open innovation in this field, a growing number of banks and financial institutions in Japan are now opening up their API to fintech ventures so that they can gain secure access to data and core banking processes including payments and remittance. This "open API" movement has gained momentum under the new legislation that obliges banks to use their best efforts to develop an open API system (see above). Examples of the open API initiatives taken by Japanese banks and financial companies are as follows:

Table 3.11 Examples of corporate initiatives for open API in Japan	
SBI Sumishin Net Bank (Japan)	In March 2016, SBI Sumishin Net Bank, a joint venture created by SBI and Sumitomo Trust Bank, which is a member of Sumitomo Mitsui Financial Group, started to offer new service connecting with Money Forward's service via API.[157] With this API connection, customers can get information, while using the Money Forward's services, about account balance and account activities in a safer and more convenient environment, without the need to give their bank's login ID and password to Money Forward.
NTT Data (Japan)	Since April 2016, NTT Data, Japan's largest IT service provider with the dominant share of the market with close to 70 percent of the country's private bank transactional data, has promoted a pilot project to open its internet banking API to connect the services provided by Money Forward and Freee with Shizuoka Bank, one of Japan's largest local banks.[158] NTT Data plans to expand this API link service to more fintech ventures to create various types of open-API-oriented business.
Mitsubishi UFJ Financial Group (Japan)	The Mitsubishi UFJ Financial Group (MUFG), Japan's largest banking corporation and one of the biggest financial groups in the world is now open to enabling secure access to its data from its online banking systems from third-party applications.[159] Access to MUFG tools would enable simpler payment processes and new, alternative features entirely. For instance,

[157] The press release as of 25th March 2016 published by SBI Sumishin Net Bank (Japanese): https://www.netbk.co.jp/wpl/NBGate/i900500CT/PD/corp_news_20160325.

[158] The press release as of 29th February 2016 published by NTT Data (Japanese): http://www.nttdata.com/jp/ja/news/release/2016/022900.html.

[159] The website of MUFG regarding its open API initiatives (Japanese): https://innovation.mufg.jp/api/index.html.

	artificial intelligence-based robo-advisers could help investors better manage their portfolios through automated investment advice from data analytics. Using the same application, investors can then buy their chosen financial instruments by transferring money within the same platform, all in one application. Companies looking to gain access to the bank's data through MUFG's APIs will need to pass an initial review.
Mizuho Bank (Japan)/ IBM Japan (Japan)	Mizuho Bank is implementing API interfaces to third party personal financial management apps through a collaboration with IBM. The bank will run IBM Japan's FinTech API interface, as well as IBM API Connect on the IBM Cloud and IBM DataPower Gateway.[160]

As bank data access continues to become more open, there will be more appealing options available to consumers that will encourage them to seriously consider fintech solutions as viable alternatives to traditional bank accounts.

3.8 Venture capital funds for fintech ventures

Japanese banks, including the three major megabank groups (i.e., Mitsubishi UFJ Financial Group, Sumitomo Mitsui Financial Group and Mizuho Financial Group) and other financial institutions in the country are quickly moving to capture the growth potential that fintech venture companies can offer by establishing venture capital funds targeting at fintech. Examples include the following cases:

Table 3.12 Examples of fintech venture capitals in Japan	
Rakuten	In November 2015, Rakuten, one of Japan's largest e-commerce companies, launched a USD 100 million fund to invest in fintech companies, in particular European and North American startups developing technologies for payments and money transfers.[161]

[160] The press release as of 23rd May 2017 published by IBM Japan (Japanese): http://www-03.ibm.com/press/jp/ja/pressrelease/52457.wss.

[161] The press release as of 12th November 2015 published by Rakuten (Japanese): https://corp.rakuten.co.jp/news/press/2015/1112_01.html.

Sumitomo Mitsui Asset Management	Sumitomo Mitsui Asset Management, a member of Sumitomo Mitsui Financial Group, gathered more than JPY 70 billion yen and started Global AI Fund in September 2016, which invests in companies all over the world developing AI technology for financial and other applications.[162]
SBI Holdings	SBI established a venture capital fund called SBI AI & Blockchain Fund in 2018 with the aim of investing in AI and blockchain ventures particularly in the fintech sector.[163] See Section 4 of this report.

The venture capitals mentioned-above aim not only at fintech ventures in Japan but also in foreign countries, including EU member states.

Mitsubishi UFJ Bank, a member of Mitsubishi UFJ Financial Group, which is Japan's largest bank group, has run the open innovation hub called "Innovation Hub" to develop cutting-edge fintech tools by networking with a diverse range of fintech ventures.[164]

3.9 Business matching events, venture acceleration programs, and business model contests for fintech startups

In line with the fintech boom in Japan, there are an increasing number of large-scale fintech business matching events in the country. The table below shows three examples in this regard.

Table 3.13 Examples of fintech tradeshows and symposiums in Japan

- FIN/SUM WEEK: http://finsum.jp/
- Rakuten Fintech Conference: https://corp.rakuten.co.jp/event/rfc/english/
- Rising Expo: http://www.rising-expo.com/en/

Not only Japanese fintech ventures but also foreign fintech ventures, including European fintech startups, have made their pitches in those opportunities. For example, several foreign fintech

[162] The website of Global AI Fund: http://www.smam-jp.com/fund/top/1253081_1551.html.

[163] The press release as of 17th January 2018 published by SBI: http://www.sbigroup.co.jp/news/2018/0117_10953.html.

[164] The website of Innovation Hub: https://innovation.mufg.jp/.

ventures, including the three European fintech ventures mentioned below, made their presentations in the final round of the fintech business contest in FIN/SUM WEEK 2017.

Table 3.14 European fintech ventures in FIN/SUM WEEK 2017 in Japan
• wilov (France): https://www.wilov.com/ • Tradle (UK): https://tradle.io/ • Finantix (UK): http://www.finantix.com/

At the same time, an increasing number of venture acceleration programs have been created in Japan for IT ventures, including fintech startups. Those programs are usually run for a free-of-charge for a fixed period of time to provide startups with various forms of early-stage support, including mentoring, workspace, in-house training, networking events, presentation opportunities at demo days, legal and accountancy support, and/or early-stage investment. Importantly, some of those programs have no limitation on the nationality of applicants, meaning that European entrepreneurs can apply. The table below shows four examples in this regard.

Table 3.15 Fintech Startup Accelerator Programs in Japan
• Open Innovation Contest and Digital Corporate Accelerate Program promoted by NTT Data: http://oi.nttdata.com/ • FinTech Business Camp Tokyo: http://www.seisakukikaku.metro.tokyo.jp/bdc_tokyo/english/bizcamptky/fintech/ • KDDI Mugen Labo: http://www.kddi.com/english/ventures/ • SoftBank Innovation Program: https://www.softbank.jp/en/biz/innovation/

NTT Data's Open Innovation Contest is a business model contests held by NTT Data, a member of NTT Group and Japan's largest supplier of backbone IT systems for financial institutions on an annual basis in 15 cities in the world, including five European cities, namely London, Madrid, Barcelona, Milano and Lisbon.[165] This contest aims for IT startups, including fintech startups around the world. This contest is part of the company's strategy for finding high-quality foreign and domestic fintech ventures to be invested in or partnered with. In parallel with Open

[165] The website of NTT Data Open Innovation Contest: http://oi.nttdata.com/en/contest/.

Innovation Contest, NTT Data has also organized Digital Corporate Accelerate Program for fintech ventures from all over the world.

FinTech Business Camp Tokyo is a fintech startup acceleration program that has been run by the Tokyo Metropolitan Government since 2017 under its policy vision of the "Global Financial City: Tokyo" (see below). Only foreign fintech startups wishing to do business in Japan can apply to this program. The purpose of this program is to transfer cutting-edge knowledge from foreign fintech ventures to Japanese financial companies. 52 company applicants from 16 countries and areas sent their applications, and 8 fintech ventures, including the two French ventures developing AI-based fintech, namely Quantcube Technology and Shift Technology as mentioned above.

3.10 Knowledge transfer opportunities with Japanese industry associations in the fintech field

Japan's largest industry association in the field of fintech is Fintech Association of Japan (FAJ) with more than 300 corporate members including about 100 fintech ventures. FAJ has been active in expanding its international network with fintech associations in other countries. For example, FAJ has recently engaged in the following international activities:

- Partnered with Luxembourg's fintech innovation hub called the LHoFT Foundation[166] and Bahrain FinTech Bay,[167] respectively;
- Organized the seminar on fintech business in Lithuania in 2017, in collaboration with the Embassy of Lithuania in Tokyo[168];

[166] The press release as of 29th November 2017 published by FAJ (Japanese): https://www.fintechjapan.org/news/5605436. Also see the website of the LHoFT Foundation: http://www.lhoft.com/.
[167] The press release as of 29th November 2017 published by FAJ (Japanese): https://www.fintechjapan.org/news/5605754. Also see the website of Bahrain FinTech Bay: https://www.bahrainfintechbay.com/press-kit.
[168] The press release as of 21st November 2017 published by FAJ (Japanese): https://www.fintechjapan.org/news/5595610.

- Organized Japan Fintech Night in collaboration with FINNOVASIA within Hong Kong Fintech Week in 2017[169];
- Cooperated as a media partner for the promotion of Money 20/20 in 2017, which is one of the world's largest fintech events[170]; and
- Organized the fintech venture workshop in collaboration with the Embassy of Norway in Tokyo in 2017[171].

Creating networks between fintech industry associations in the EU and FAJ may result in providing EU fintech ventures with opportunities to efficiently approach potential Japanese partners and investors.

3.11 The Tokyo Metropolitan Government's vision of the "Global Financial City: Tokyo"

In 2017, the Tokyo Metropolitan Government announced its policy vision of the "Global Financial City: Tokyo" with the aim of turning itself into one of the world's most advanced financial cities.[172] What is behind this is the fact that Tokyo used to be one of the largest global financial centers rivaling New York and London but now it is viewed as being behind Hong Kong and Singapore as a top global financial center.

An important part of this vision is to "nurture fintech businesses" and to promote the establishment of a fintech business ecosystem in Tokyo. One of the initiatives the Tokyo Metropolitan Government has taken for this purpose is to attract a diverse range of fintech companies from around the world to Tokyo.[173] FinTech Business Camp Tokyo is being run

[169] The press release as of 19th October 2017 published by FAJ (Japanese): https://www.fintechjapan.org/news/5321622.

[170] The press release as of 24th July 2017 published by FAJ (Japanese): https://www.fintechjapan.org/news/4991615. Also see the website of Money 20/20: https://asia.money2020.com/.

[171] The press release as of 28th March 2017 published by FAJ (Japanese): https://www.fintechjapan.org/news/4737299.

[172] Tokyo Metropolitan Government, 2017, "Global Financial City: Tokyo" vision – towards the Tokyo Financial Big Bang. Available at: http://www.seisakukikaku.metro.tokyo.jp/GFCT/english/pdf/291110finalreport.pdf. Also see the website of the Tokyo Metropolitan Government: http://www.seisakukikaku.metro.tokyo.jp/GFCT/english/.

[173] Tokyo Metropolitan Government, 2017, Immediate Measures for Attracting Foreign Financial Companies.

under this policy scheme (see Section 3.9 above). Tokyo Metropolitan Government will also promote the set-up of various services with the aim of assisting foreign financial professionals in Japan, such as medical services by non-Japanese licensed foreign doctors, among others.

In 2017, the Tokyo Metropolitan Government and the City of London Corporation signed a Memorandum of Understanding (MoU) which will result in closer collaboration between the financial and professional services sectors in both cities.[174] The four-year agreement will aim to boost cooperation in a number of areas including:

- fintech and innovation;
- asset management;
- developing international standards in areas like green finance and environmental, social and governance (ESG) investment; and
- promoting, retaining and growing mutual investment activity in light of Brexit.[175]

As a result of this memorandum, the number of cases of knowledge transfer from UK fintech ventures to Japanese financial companies is expected to increase. On the other hand, how Brexit will impact on the knowledge transfer from UK fintech ventures to Japanese financial counterparts in the long term remains to be seen. Berlin and Paris have promoted campaigns to try to attract London-based startups to their own hubs, claiming that those startups can continue, if relocated to those cities, to benefit from the EU regulation that allows their financial products to easily cross borders within the territory of the EU. Other European cities such as Amsterdam, Stockholm, Helsinki, and Copenhagen also seem interested in replacing London, at least to a certain extent, as the fintech capital of Europe.

Available at: http://www.seisakukikaku.metro.tokyo.jp/GFCT/english/pdf/290113tomeneng.pdf.

[174] The memorandum is available at: http://www.metro.tokyo.jp/ENGLISH/TOPICS/2017/FILES/171204.pdf.

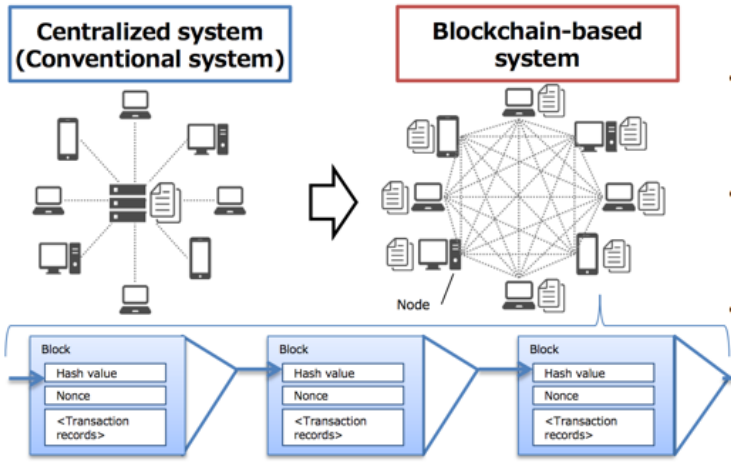
[175] There is a plan, within this partnership, to co-organize educational programs for high-quality Japanese financial talents under the initiative of universities in London and Tokyo Metropolitan University, which was established by the Tokyo Metropolitan Government in 1949 and has been one of the leading research universities in Japan.

4. Blockchain Technology

4.1 Blockchain as a revolutionary technology

The blockchain is a recent development in the field of computer science, which uses a global peer-to-peer network to provide an open platform that is not "owned" by anyone, offers the opportunity to share data between parties *without the need for a third party*, and are typically designed to be reliable, secure and deliver neutrality. New information cannot be removed or changed after it has been written. The basic mechanism was originally proposed by Bitcoin-founder Satoshi Nakamoto to serve as the public ledger for all Bitcoin transactions.

Figure 4.1 The concept of blockchain technology

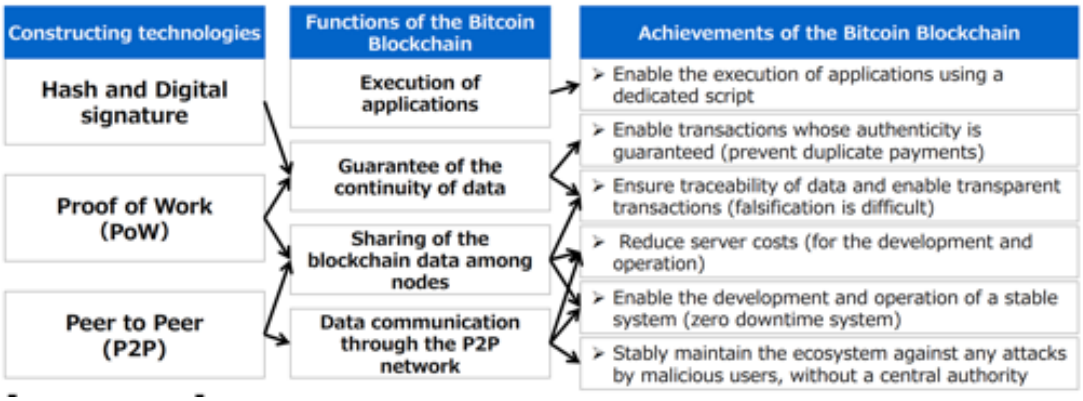


Source: METI, 2015, *Survey on Blockchain Technologies and Related Services*.[176]

Major technologies supporting the blockchain mechanism are hash, public-key cryptography and digital signature, Proof of Work, and P2P, and the combination of those technologies generates several technological advantages, as described in the figure below.

[176] Available at: http://www.meti.go.jp/english/press/2016/pdf/0531_01f.pdf.

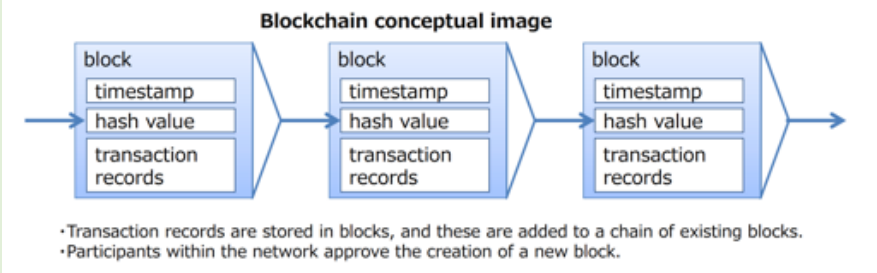
Figure 4.2 Elements of blockchain technology



Source: METI, Survey on Blockchain Technologies and Related Services FY2015 Report

Table 4.1 What is Proof of Work?

Proof of Work generally refers to a mechanism to confirm a person's innocence (or to discourage him/her to act wrong) by having him/her do a certain work. PoW is a work called mining in Bitcoin. A series of blocks created through PoW is a blockchain. Blocks compiling transaction data for a certain period of time (for approximately 10 minutes for Bitcoin) are linked into a chain and each block contains a timestamp, hash value of the preceding block, nonce, and information on transaction records included in the relevant block.



Source: METI, *Survey on Blockchain Technologies and Related Services FY2015 Report*

There is an argument that blockchain technology may not still be applicable for real-time data processing because it takes from a few seconds to 10 minutes to create and add a new block to the chain. However, rapid technology development in the blockchain field is expected to solve this issue.

4.2 Large impact blockchain technology can have on society at large

Blockchain's impact on the Japanese society for Society 5.0

The topic of how to utilize blockchain technology not only in the financial sector but also in diverse other industrial areas has recently been a very hot topic in government, industry and academia around the world. For example, in 2017, the EU Parliament published a report titled "How blockchain technology could change our lives."[177]

Japan is no exception. METI published the report titled "Blockchain Technologies and Related Services" in April 2016,[178]and the report titled "Evaluation Forms for Blockchain Based System" in March 2017.[179] In those reports, attention is paid to the utilization of blockchain technology in such areas as remittance, local currency, securities transactions, electric coupons, land registration, patent or copyright transaction, electric health records, voting, supply chain traceability, smart locks, energy control, and so on.

With its huge potentiality as the fundamental technology for a wide range of digital infrastructure, blockchain technology is expected to function as the essential basis for the "super smart society" or "Society 5.0" envisioned in the 5th Science and Technology Plan (Table 1.2).[180] In the report titled "Blockchain Technologies and Related Services," METI estimates that the blockchain market will expand up to JPY 67 trillion in Japan (see Figure 4.3 below).

Figure 4.3 Blockchain technology's impact on society at large in Japan

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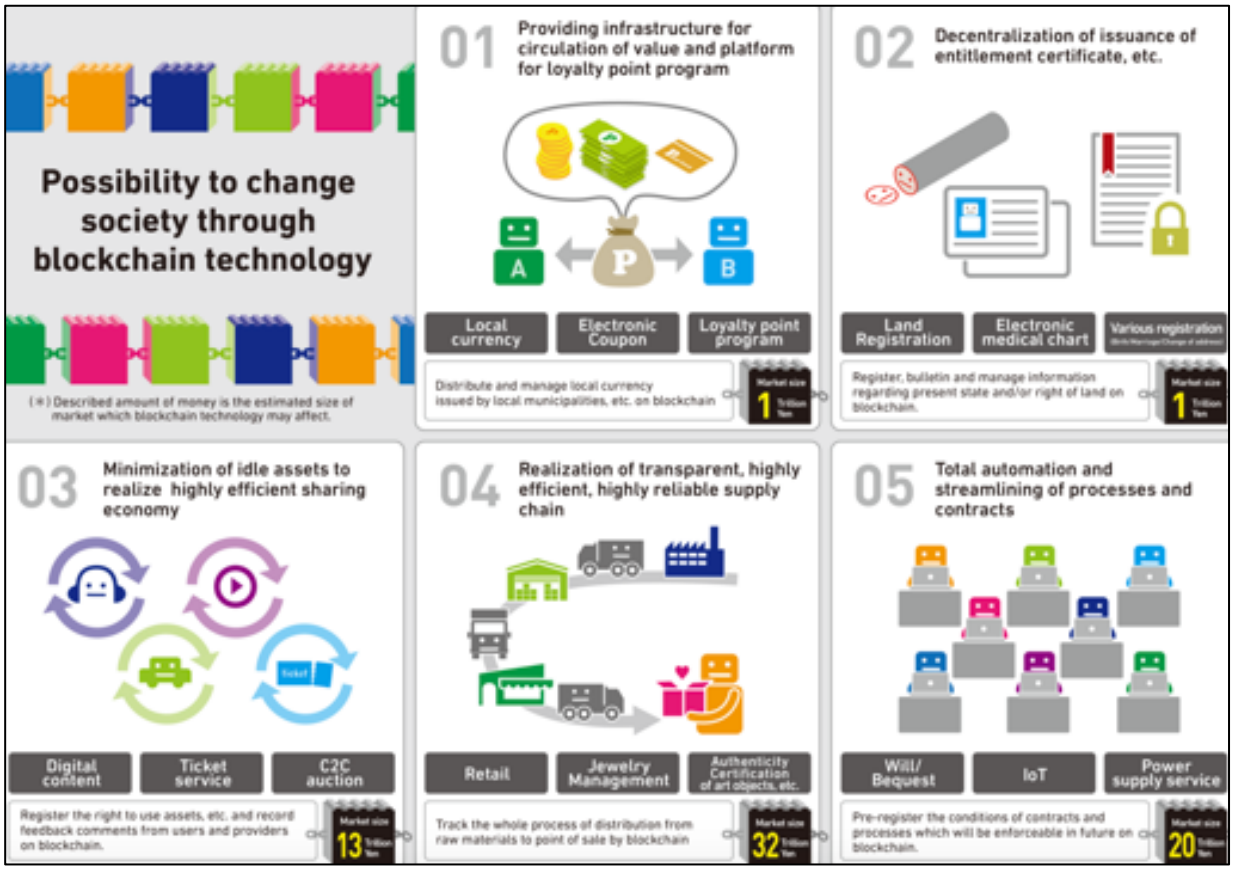
[177] The European Parliament, 2017, *How blockchain technology could change our lives*. Available at: http://www.europarl.europa.eu/RegData/etudes/IDAN/2017/581948/EPRS_IDA(2017)581948_EN.pdf.

[178] The press release as of 31st May 2016 published by METI: http://www.meti.go.jp/english/press/2016/0531_01.html.

[179] The press release as of 29th March 2017 published by METI: http://www.meti.go.jp/english/press/2017/0329_004.html.

[180] The Cabinet Office of the Japanese government, 2015, *The 5th Science and Technology Basic Plan*. Available at: http://www8.cao.go.jp/cstp/kihonkeikaku/5basicplan_en.pdf.



Source: METI, *Blockchain Technologies and Related Services FY2015 Report*.[181]

Blockchain technology for achieving the SDGs

At the same time, the United Nations has paid keen attention to the utilization of blockchain technology for advancing the United Nations' Sustainable Development Goals (SDGs).[182] In this regard, a growing number of blockchain-based projects have already been created under the initiative of various UN agencies.[183] The Japanese government established the Sustainable Development Goals (SDGs) Promotion Headquarters within the Cabinet Office in 2016 with the aim of promoting measures related to the SDGs through the partnership with a diverse range of entities.[184] Prime Minister Abe regards the "joint promotion of Society 5.0 by the public and

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[181] Available at: http://www.meti.go.jp/english/press/2016/0531_01.html.

[182] UNITE, 2017, *Usage of Blockchain in the UN System A DESK REVIEW*. Available at: https://unite.un.org/sites/unite.un.org/files/session_3_b_blockchain_un_initiatives_final.pdf.

[183] The website of UN Blockchain: https://un-blockchain.org/.

[184] The website of the Sustainable Development Goals (SDGs) Promotion Headquarters within the Cabinet Office of the Japanese government: https://www.kantei.go.jp/jp/singi/sdgs/.

private sectors" as being "closely linked to the SDGs."[185] An increasing number of Japanese companies have expressed their interest in contributing to achieving the SDGs as a matter of their corporate strategy. There may be chances, therefore, for EU blockchain ventures to partner with Japanese companies to co-develop blockchain-based systems for solving global as well as domestic issues as defined in the SDGs. In this regard, the utilization of blockchain technology for food traceability (Section 4.4) and for the creation of peer-to-peer energy transaction marketplaces (Section 4.6) is deeply related to the achievement of the SDGs. Promoting the development of automated driving technologies can also contribute to achieving the SDGs, since it can lead to lowering CO2 emissions from the transportation sector (see Table 1.4).

Table 4.2 The Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) were adopted as the 2030 Development Agenda at the UN General Assembly on September 25, 2015 as the goals that international society must achieve by 2030. The SDGs are a set of 17 goals targeting issues such as poverty, hunger and food security, health, energy, climate change, and responsible production and consumption, among others.

Diagram from the website of the United Nations.[186]

[185] The website of the Cabinet Office of the Japanese government: https://japan.kantei.go.jp/98_abe/actions/201712/26article3.html.

[186] Available at: https://sustainabledevelopment.un.org/sdgs.

4.3 Possible blockchain technology areas for knowledge transfer from European blockchain ventures to Japanese counterparts

While the application of blockchain technology in diverse industrial areas is still in the first incubation stage in Japan, keen attention has been paid by relevant Japanese entities in government, industry and academia to various types of blockchain-based business models or public systems being promoted by foreign companies or governments. In fact, there are Japanese companies that have already started collaborating with foreign blockchain ventures, including EU blockchain ventures, as will be mentioned below. The table below shows examples of possible blockchain technology area for knowledge transfer with Japanese counterparts.

Table 4.3 Possible blockchain technology areas for knowledge transfer with Japanese counterparts

- Payment and money transfer (see Section 3 “Fintech” of this report)
- Automated driving systems (see Section 1 “Automated Driving Technology” of this report)
- Cybersecurity for critical infrastructure (see Section 2 “Cybersecurity” of this report)
- Copyright transactions (see Section 9 “Technology for Art and Music Business” of this report)
- Food traceability
- Trade administration
- Traceability for luxurious goods
- Peer-to-peer energy transaction marketplace
- Insurance
- HR credential management
- Smart lock in the context of sharing economy
- E-Government services

4.4 Knowledge transfer opportunities in the area of blockchain technology for food traceability

The importance of food traceability

Nowadays, many foods people consume come from global food supply chains distributed across global markets. And, due to a large number of food-related issues such as contamination, food-borne illness, food fraud, and rapidly declining food resources (e.g. seafood resources), how to secure the traceability of food through complex global value chains has been discussed around the world.

Food traceability is a risk-management tool which allows food business operators or authorities to withdraw or recall products which have been identified as unsafe. Food traceability is also an important system which gives consumers vital information about all movement of food products and all steps within the food production process throughout the global value chain, thereby significantly influencing the patterns of consumers' buying behavior.

Seafood Traceability

Traceability can be a very important issue regarding a variety of food products. In this regard, one of the food categories that have frequently been connected with the issue of food traceability is seafood, especially in view of the fact that global fish stocks are rapidly declining.[187] In this regard, the Fisheries Policy Group in the Regulation Reform Committee within the Cabinet Office of the Japanese government, which started in 2017, has now engaged in the discussion of how to promote seafood traceability in Japan.[188]

Table 4.4 IUU and seafood traceability
The issue of seafood traceability is often discussed in connection with the issue of IUU (illegal, unreported, and unregulated) fishing as well as with seafood fraud and public health risks. IUU fishing

[187] *The Guardian*, the online article "Global fish production approaching sustainable limit, UN warns" as of 7th July 2016. Available at: https://www.theguardian.com/environment/2016/jul/07/global-fish-production-approaching-sustainable-limit-un-warns. Also see: *The Japan Times*, the online article "Managing declining fish stocks" as of 28th May 2014. Available at: https://www.japantimes.co.jp/opinion/2014/05/28/editorials/managing-declining-fish-stocks/#.WrXzLdPFIgo.

[188] The website of the Cabinet Office of the Japanese government: http://www8.cao.go.jp/kisei-kaikaku/suishin/meeting/wg/suisan/20170920/agenda.html.

has been regarded as one of the important causes of the rapidly declining stocks of global seafood resources. IUU-oriented seafood may be brought to market at a lower price as unfair competition to the same products from the regulated supply or as a mislabeled competing product. In either situation, the IUU-oriented contribution to the market may lower the overall quality and price of seafood products available, thus creating an economic burden on fishermen following the laws and regulations. IUU fishing is also linked to human trafficking and forced labor, referred to as "seafood slavery." IUU fishing can also lead to increased pressure on endangered fish species. A vital approach to fighting against IUU fishing is traceability. Traceability increases transparency and accountability in the seafood supply chain by ensuring that information such as how and where fish are caught or farmed follows the fish from boat to plate. The ability to share information along the seafood supply chain reduces the risk of seafood fraud and helps prevent IUU-oriented product from entering the market. How to secure the traceability of food is also of vital importance in terms of achieving the SDGs.

Sustainable food initiatives in Japan and the Tokyo Olympics

A growing number of large retail store chains in Japan, including Seven & I Holdings Company, Aeon Company and Seiyu, have expressed concerns about food sustainability issues, and have adopted procurement policy to secure the traceability of food through global food supply chains. The momentum for food traceability and sustainability is expected to further increase in Japan, in view of the fact that the Tokyo Organising Committee of the Olympic and Paralympic Games has adopted the sustainable sourcing code to promote the private initiative for food traceability and sustainability.

Table 4.5 The Sustainable Sourcing Code of the Tokyo Organising Committee of the Olympic and Paralympic Games

"To ensure the sustainable sourcing of products and services deemed vital to the successful delivery of the Tokyo 2020 Games, and in consideration of economic rationality, fairness and equity, the Tokyo 2020 Fundamental Principles for the Sustainable Sourcing Code sets out the fundamental principles that will provide the foundation for the Code, and serve as a guide for the establishment of specific contents to be included in the Sourcing Code."

Source: Tokyo 2020 Fundamental Principles for the Sustainable Sourcing Code[189]

[189] The website of the Tokyo Organising Committee of the Olympic and Paralympic Games: https://tokyo2020.org/en/games/sustainability/.

Blockchain as a revolutionary tool for food traceability in global supply chains

Complex structure of the global food supply chains makes it difficult to create a client-server-model-based traceability system in it. This is the reason why a blockchain-based decentralized system can play a vital role in promoting food traceability. Using blockchain technology will bring transparency to global food supply chains, allow consumers to make informed purchases and empower governments to quickly and easily request reliable information related to even the most distant supplier *without the need for a third party*. Blockchain systems can provide confidence around key attributes of purchased goods — such as ethical standards, origin and authenticity — all easily verified through a smartphone-readable QR-code. In this way, 'Made in', 'Made with' and 'Made by' must all become the values by which products are judged. This technology shift is already occurring, but it will be blockchain technology that truly facilitates the revolution.

Accordingly, the interest in utilizing blockchain technology food traceability has been growing in Japan, and several pilot projects have been promoted for utilizing that technology in the traceability mechanisms for agricultural products. For example, ISID, a subsidiary of Dentsu (see Section 6 "Martech"), is now promoting the application of blockchain technology to the traceability of organic vegetables in a pilot project in the Miyazaki Prefecture in Japan.[190] Other large Japanese IT consulting firms including NTT Data and Nomura Research Institute have also shown interest in the potentiality of blockchain technology for food traceability.

Keen attention paid to blockchain-based food traceability systems promoted by entities in other countries

In this regard, keen attention has been increasingly paid by Japanese entities to emerging blockchain-based global food traceability systems created by entities in other countries. For example, the blockchain-based food traceability initiative taken by Walmart and a group of food giants, including Unilever, Nestlé, and Dole, has already received media coverage in Japan. Those companies are now teaming up with IBM in terms of using blockchain technology to maintain secure digital records and improve the traceability of their food products, such as

[190] The press release as of 22nd March 2017 published by ISID (Japanese): https://www.isid.co.jp/news/release/2017/0322_1.html.

chicken, chocolate, bananas and seafood.[191] They see blockchain technology as an effective tool to revamp their data management processes across a complex network that consists of farmers, brokers, distributors, processors, retailers, regulators, and consumers.

Initiatives taken by European ventures in the development of blockchain-based global food traceability systems will also gain keen attention in Japan. The table below shows three examples of European ventures in this regard.

Table 4.6 Examples of European ventures with blockchain technology for food traceability

Provenance (UK)	Provenance uses the blockchain to establish the authenticity of high value goods, including food.  Source: Provence's website.[192]
arc-net (Ireland)	arc-net is a venture company that has developed a blockchain-based platform for supply chain authentication and security. Since 2017, arc-net has partnered with Adelphi, one of Scotland's most acclaimed bottlers of rare single cask and limited edition single malt whisky, to eliminate the risk of fraudulent substitutions by placing Adelphi's latest limited-edition spirit release on arc-net's platform. By using the blockchain, whisky connoisseurs can follow each bottle's unique story from the distillery to the supplier network to the customer through the scanning of a unique QR code.[193] Also, in 2017, arc-net announced a partnership with PwC

[191] Robert Hackett, "Walmart and 9 Food Giants Team Up on IBM Blockchain Plans," 22nd August 2017, *Fortune*. Available at: http://fortune.com/2017/08/22/walmart-blockchain-ibm-food-nestle-unilever-tyson-dole/.

[192] Available at: https://www.provenance.org/case-studies.

[193] The press release as of 27th September 2017 published by arc-net: https://arc-net.io/blog/arc-net-adelphi-partnership-blockchain/.

	Netherlands in terms of combining their specialist industry knowledge to create a new model for food integrity, supply chain security and compliance.[194]
Ambrosus (Switzerland)	Ambrosus is a Swiss company based on the technologies for sensors and blockchain to reliably record the entire history of food "from farm to fork." Officially endorsed by EIT Food[195] and SQS (Swiss Quality and Safety Association), Ambrosus boasts the support of significant global bodies and associations including the United Nations, EPFL (Ecole Polytechnique Fédérale de Lausanne), the Crypto Valley Association, and financial backing from the Government of the Canton of Vaud, Switzerland. As the official partner of the 10YFP Sustainable Food Systems Programme, the flagship programme of the United Nations to align the global food supply chains and industries with the objectives of SDGs, Ambrosus showcased their blockchain solution at the Global Food Conference of the United Nations in South Africa in June 2017.

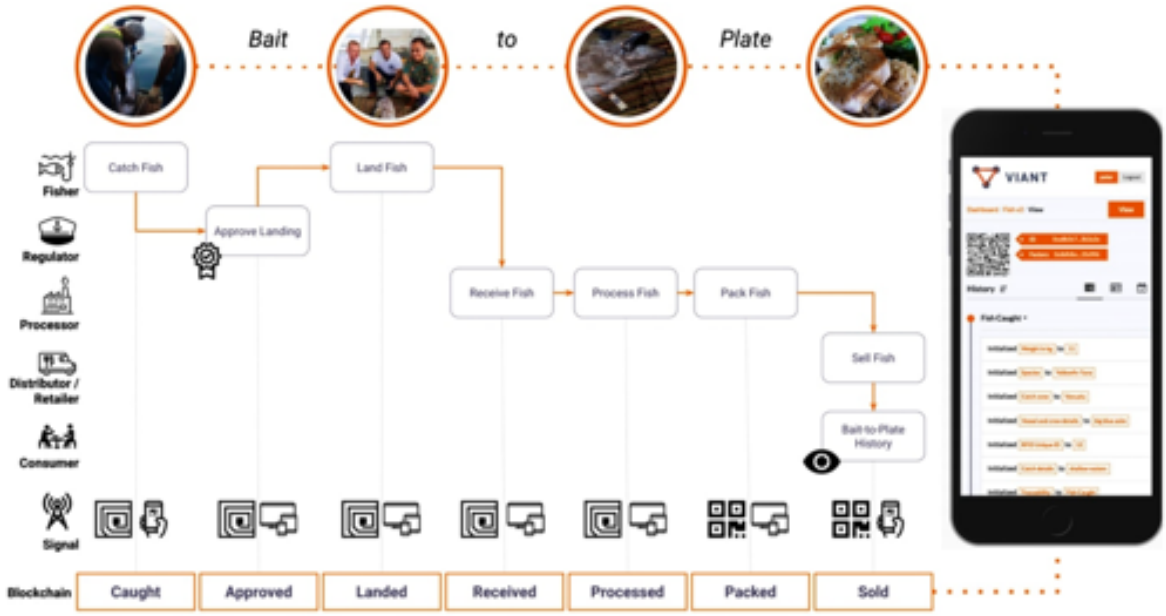
A pilot project for seafood traceability being promoted by WWF-New Zealand, WWF-Australia, and WWF-Fiji as well as the blockchain developer ConsenSys, the Fijian Tech startup TraSeable and the tuna fishing and processing company Sea Quest Fiji can be an archetype for a blockchain-based global seafood traceability system that Japanese entities, including large retailers such as Seven & I, Aeon and Seiyu, would wish to create with the assistance of European blockchain ventures.[196] This Fijian project will test the use of Viant, a blockchain-based supply chain platform, in the Pacific tuna industry. The buying and selling of Pacific tuna is currently either tracked by paper records, or not at all. Under the Viant system, fishermen can register their catch on the blockchain through radio-frequency identification (RFID) e-tagging and scanning fish.

[194] The press release as of 30th August 2017 published by arc-net: https://arc-net.io/blog/arc-net-pwc-blockchain-food-fraud/.

[195] The website of EIT Food: https://eit.europa.eu/eit-community/eit-food.

[196] For the information regarding this project, see the press release as of 8 January 2018 published by WWF: http://wwf.panda.org/?320232/New-Blockchain-Project-has-Potential-to-Revolutionise-Seafood-Industry.

Figure 4.4　Schematic of how a blockchain seafood traceability system would work, based on the partnership between WWF, Viant, ConsenSys, TracSeable Solutions and Sea Quest Fiji.



Source: Jessica Leber, "Betting on Blockchain to Put Truly Sustainable Seafood on Dinner Plates," as of 28th February 2018, *Oceans Deeply*.[197]

EU–Japan EPA, wine traceability and authenticity, and blockchain technology

The EU-Japan Economic Partnership Agreement (EPA), which was finally agreed in December 2017, will increase trades of various foods and beveradges between the EU and Japan, and may activate the topic of how to secure the traceability of foods traded between the two areas. In this regard, how to create blockchain-based food traceability systems between the EU and Japan may become a hot topic, especially in relation to the traceability and authenticity of wine, which is one of the most counterfeited products in the world.

The EU-Japan EPA will offer preferential access for imports between the EU and Japan, eliminating an import tariff on imported goods between the parties. As far as wine is concerned, Japan will levie an import tariff of 15% or JPY 125 yen per liter, whichever is less, on wine produced in EU member nations. Japan is by far the second largest wine market in Asia behind

[197] Available at: https://www.newsdeeply.com/oceans/articles/2018/02/28/betting-on-blockchain-to-put-truly-sustainable-seafood-on-dinner-plates.

mainland China, and is the 5th largest export market for EU wines. Imported wines currently account for about 70 per cent of the Japanese wine market. The EU-Japan EPA will further promote wine exports from the EU to Japan. It may also facilitate the recent trend of international co-production of wine between EU winemakers and Japanese beveradge companies. A typical case of international wine production in this regard is where a EU winemaker makes wine based on the information from a Japanese counterpart regarding Japanese people's taste preference, and the Japanese counterpart sells the co-produced wines, by using the brand power of the EU winemaker, through its diverse distribution channels in the Japanese market.

Table 4.7 Examples of knowledge transfer from EU winemakers to Japanese companies for wine co-production

- The wine co-production between Freixenet (Spain) and Suntory (Japan) in 2017[198]
- The wine co-production between Suntory (Japan) and Castel (France), Cantine Leonardo Da Vinci (Italy) and P.J. Valckenberg (Germany), respectively, in 2017[199]
- The wine co-production between Sogrape (Spain) and Suntory (Japan) in 2016[200]
- The wine co-production between the University of Bordeaux (France) and Chaeau Mercian (Japan) in 2016[201]
- The wine co-production between Codorníu (Spain) and Chaeau Mercian (Japan) in 2017[202]
- The wine co-production between Kaltern (Italy) and Asahi Beer (Japan) in 2017[203]
- The wine co-production between Coop Italy (Italy) and Coop Japan (Japan) in 2011[204]
- The wine co-production between the Despagne family (France) and Seijo Ishii (Japan) in 2015[205]

[198] The news release as of 14th February 2017 published by Suntory (Japanese): https://www.suntory.co.jp/news/article/12840.html.

[199] The news release as of 13th November 2017 published by Suntory (Japanese): https://www.suntory.co.jp/news/article/13054.html?rss=0000000029.

[200] The news release as of 12th January 2016 published by Suntory (Japanese): https://www.suntory.co.jp/news/article/12554.html.

[201] The website of Chateau Mercian regarding Koshu Kiiroka (Japanese): http://www.chateaumercian.com/lineup/district/koshu_kiiroka.html.

[202] The news release as of 27th March 2017 published by Kirin (Japanese): http://www.kirin.co.jp/company/news/2017/0327_01.html.

[203] The news release as of 28th April 2017 published by Asahi Beer (Japanese): https://www.asahibeer.co.jp/news/2017/0428_1.html.

[204] The news release as of 8th September 2011 published by Coop Japan (Japanese): https://jccu.coop/info/newsrelease/2011/20110908.html.

[205] The news release as of 18th August 2015 published by Seijo Ishii (Japanese): http://www.seijoishii.co.jp/whatsnew/press/desc/153.

On the other hand, the conclusion of the EU-Japan EPA means that the EU and Japan mutually ensure the protection of the geographical indications (GIs) of their branded foods and beveradges. As far as wine is concerned, following the conclution of EU-Japan EPA, Japan's National Tax Agency (NTA) approved 139 proposed geographical indications (GIs) for wine, spirits, and other alcoholic beverages for which the EU sought protections in Japan.[206] On the other hand, the EU approved Japan's wine GI "Yamanashi" and several sake GIs. Based on the protection of those Japanese GIs in the EU, the Japanese government will further promote the export of Japanese wine and sake to the EU as part of its Cool Japan initiative. (For the information on the Cool Japan initiative, see Section 7.2 of this report.)

Again, this may activate the discussions among various entities in the EU and Japan regarding how to secure the traceability and authenticity of GI-protected foods, including wine (and Japanese sake, because of prevailing fake Japanese sake[207]). In the EU, there are a growing number of pilot projects to utilize blockchain technology to combat against wine fraud. One of such projects is the one being promoted by the London-based blockchain venture Everledger (see Section 4.6 of this report) in collaboration with IBM.[208]

Table 4.8 Wine fraud

The most prevalent type of wine fraud is the case where wines are adulterated, usually with the addition of cheaper products (e.g. juices) and sometimes with harmful chemicals and sweeteners (compensating for colour or flavour). Counterfeiting and the relabelling of inferior and cheaper wines to more expensive brands is another common type of wine fraud. A new report from the European Union Intellectual Property Office (EUIPO) shows that 4.4% of legitimate sales of spirits and 2.3% of legitimate sales of wine are lost each year due to counterfeiting of alcoholic drinks. Those lost sales translate into 4,800 jobs directly lost across the spirits and wine sectors in the EU, as legitimate manufacturers employ fewer people than they would have done in the absence of counterfeiting.[209]

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[206] The press release as of 6 July 2017 published by the Ministry of Finance (Japanese): http://www.mofa.go.jp/mofaj/files/000286938.pdf.

[207] *Nikkei Shimbun*, the online article as of 4th July 2015 (Japanese): https://www.nikkei.com/article/DGKKASDZ01H23_T00C15A7TI5000/.

[208] See the article titled "The power of blockchain + Watson" as of 22nd May 2017 on the website of IBM: https://www.ibm.com/blogs/research/2017/05/power-blockchain-watson/.

[209] EUIPO, 2016, *The economic cost of IPR infringement in the spirits and wine sector*. Available at:

4.5 Knowledge transfer opportunities in the area of blockchain technology for trade administration

The procedures for international trade involve exchanges of information through contracts, certificates and approvals between numerous entities, including customs and other regulatory agencies. Those procedures require significant man-power at high costs or otherwise provide opportunities for error and fraud. Differing trade regulations and documentation standards predominate between different countries make these procedures all the more complex ones.

These technical hurdles in the administrative procedures for international trade may also be relevant to the topic of how to secure the traceability of food (see Section 4.4 above), if there is a legal obligation for the traceability of imported food products. For example, as a matter of legal obligation under the EU Illegal, Unreported and Unregulated (IUU) Regulation 1005/2008, any fishery products intended for export to the EU must be accompanied by a catch certificate, and the responsibility for obtaining a catch certificate for that seafood falls on the exporter.[210]

Blockchain technology can contribute to making all of these processes significantly more efficient and transparent. Using blockchain technology will diminish the need to secure each transaction or step in the supply-chain through intermediaries via registration, tracking and certification. Information on any shipment – whether it be a proof of purchase, a clearance form, a bill of lading, insurance – can be made part of a block, a transparent chain of custody in the blockchain system, and be accessible to suppliers, transporters, buyers, regulators and auditors. Having all this information in one location would not only lower transaction costs but also decrease auditing and accounting costs as well.

In this regard, in collaboration with the Government of Singapore, NTT Data and the Bank of Tokyo-Mitsubishi UFJ, Mitsubishi UFJ Financial Group's (MUFG) banking entity, started a blockchain-based pilot system that will establish efficient trade procedures and practices

https://euipo.europa.eu/ohimportal/en/web/observatory/ipr_infringement_wines_and_spirits.

[210] The website of the Fisheries Agency of the Japanese government: http://www.jfa.maff.go.jp/j/kakou/eu/IUU/Information.html.

between the two countries, as shown in the table below. In view of the furtherance of trade between the EU and Japan as a result of the EU-Japan EPA, the same kind of blockchain-based trade administration system may be established to facilitate the establishment of efficient trade procedures and practices between the two areas with the involvement of cutting-edge EU blockchain ventures.

Table 4.9 Example of blockchain-based trade administration system

The Singaporian government/ NTT Data (Japan)/ The Bank of Tokyo-Mitsubishi UFJ (Japan)	In 2017, in collaboration with the Singaporian government's National Trade Platform (NTP), NTT Data and the Bank of Tokyo-Mitsubishi UFJ started a blockchain-based pilot system that would strengthen trade ties between Singapore and Japan.[211] This initiative aims to establish efficient trade procedures and practices between the two countries with the long-term goal of fostering greater trade and supply chain integration across the region. In this system, MUFG and NTT DATA will utilize an application programming interface (API) to connect a prototype trade system currently developed by NTT Data with Singapore's NTP. This system is expected to complement Singapore's SMART Nation objectives and efforts at developing a regional digital economy. MUFG is a partner of initiatives spearheaded by the Monetary Authority of Singapore (MAS), including the linkage of NTP to trade platforms in other countries such as Hong Kong's, and the MAS-led consortium focused on developing blockchain-based inter-bank payment solutions.

In 2017, NTT Data also launched a consortium consisting of 13 major companies from sectors such as banking, insurance, integrated logistics and import and export to collaborate in this area. MUFG is one of the companies in this consortium.[212]

[211] The press release as of 5th December 2017 published by NTT Data: https://www.nttdata.com/global/en/media/press-release/2017/december/mufg-and-ntt-data-lay-foundation-for-digital-trade-between-singapore-and-japan-using-blockchain.

[212] The press release as of 15th August 2017 published by NTT Data (Japanese): http://www.nttdata.com/jp/ja/news/services_info/2017/2017081501.html.

4.6 Knowledge transfer opportunities in the area of blockchain technology for luxurious goods

Utilization of blockchains for managing each piece of precious metals and jewels, such as gold and diamonds, from their processing stages will enable purchasers to check the processing records of products and this may increase credibility of products. In this regard, Everledger has already received some media coverage in Japan.

Table 4.10 Example of European blockchain technology for luxurious goods traceability

Everledger (UK)	Everledger is a London-based startup that is using blochchain technology to upgrade the traceability of luxurious goods such as diamonds. The diamond industry is beginning to adopt Everledger's blockchain-based traceability system for diamonds, which has the following three stages: • Establish an e-ID (electronic identity) for each diamond, by digitising its attributes and a laser-inscribed serial number onto an authoritative block chain ledger; • Assign a digital passport to the diamond to record its travel, transaction history and provenance; and • Detect and guard against illegal activities or fraudulent behavior. Everledger's blockchain-based diamond traceability system has been utilized to promote the Kimberley Process, which is a commitment to remove conflict diamonds from the global supply chain.[213]

In Japan, a group of researchers at Keio University has engaged in the utilization of blockchain technology for anti-counterfeits purposes, and published a research paper titled "A Novel Blockchain-Based Product Ownership Management System (POMS) for Anti-Counterfeits in The Post Supply Chain" in the IEEE Access published in 2017.[214]

[213] The website of the Kimberley Process: https://www.kimberleyprocess.com/.

[214] Available at: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7961146.

4.7 Knowledge transfer opportunities in the area of blockchain technology for peer-to-peer energy transaction marketplaces

In Japan, there is an ever-growing demand for "local production for local consumption" of renewable energy, following the collapse of public trust in nuclear power due to the Tohoku earthquake and tsunami on March 11, 2011, and subsequent triple meltdowns at the Fukushima No. 1 nuclear power plant. To promote the generation and use of renewable energy in this regard, in 2012, the Japanese government introduced the feed-in tariff (FIT) system, where utilities are obliged to purchase solar, wind, mini-hydro, geothermal and biomass-generated electricity from eligible renewable electricity generators, including homeowners, business owners, farmers and private investors, at a fixed rate for a fixed number of years.[215] Since the 2012 feed-in tariffs were introduced, the renewable energy business sector in Japan has continued to expand, and the percentage of renewable energy jumped from about 9 percent nationwide in fiscal 2011 to 15 percent in fiscal 2016. At the same time, the high tariffs offered in 2012 has come down, with the Japanese government making adjustments to the feed-in tariff scheme each year.

Now that the first FIT for residential solar power plants is scheduled to end in 2019, keen attention is being paid to the creation of peer-to-peer energy transaction marketplaces. With a P2P energy trading system, a household can sell electricity to another house in their neighborhood, bypassing the middleman. The creation of peer-to-peer energy transaction marketplaces is also important in terms of Japan's commitment to achieving the United Nations' SDGs (see Table 4.2 above).

Importantly, blockchain technology can be the basic technology for peer-to-peer energy transaction marketplaces. For example, in Brooklyn, the New-York-based venture LO3 Energy has teamed up with Siemens to create a pilot microgrid using blockchain technology.[216] In this scheme, residents with solar panels can sell excess energy back to their neighbours, in a peer-to-peer transaction through the blockchain-based microgrid. Microgrids can minimise the

[215] Several English materials regarding the FIT system are downloadable from the website of METI: http://www.meti.go.jp/english/policy/energy_environment/renewable/index.html.

[216] The website of LO3 Energy: https://lo3energy.com/.

amount of energy lost through transmission; as an estimated 5% of electricity created in the US is lost in transit, microgrids provide an efficient alternative. The Brooklyn microgrid also economically benefits those who have installed solar panels and their local community, and makes the community resilient against emergency situations from natural disasters such as earthquakes.

Being egar to have a grip on the blockchain-based P2P energy trading, Japanese utility giants are increasingly interested in partnering with ventures with cutting-edge blockchain technology. In this regard, Tokyo Electric Power Company (TEPCO), which is the largest utility in Japan serving millions of homes and businesses, has recently been active in investing in foreign blockchain ventures in this field, as shown in the table below.

Table 4.11 TEPCO's investment in foreign blockchain ventures for peer-to-peer energy transaction marketplaces	
Conjoule (Germany)	In 2017, TEPCO invested EUR 4.5 million in Conjoule, a Germany-based startup that is specialized in developing peer-to-peer energy trading solutions using blockchain.[217] Conjoule is building disruptive new digital business models that fundamentally redesign the way that energy market participants interact with each other. The company's first product, which is currently in pilot testing, enables residential solar photovoltaic owners to sell their excess electricity to local consumers on its blockchain-enabled platform. The platform will provide market access for grid edge assets to market energy, capacity and flexibility.
Electron (UK)	In January 2018, TEPCO invested in Electron, a UK energy technology venture.[218] Electron has formerly been the recipient of UK government grants to produce a blockchain-based solution suitable for energy providers. Electron has also used the Ethereum blockchain to test a pilot program for a decentralized energy grid, so it may be possible that Ethereum will play a role in the projects promoted by Electron for TEPCO.

[217] The press release as of 10th July 2017 published by TEPCO: http://www.tepco.co.jp/en/press/corp-com/release/2017/1443967_10469.html.

[218] The press release as of 19th January 2018 published by TEPCO: http://www.tepco.co.jp/en/announcements/2018/1473674_15434.html.

4.8 Knowledge transfer opportunities in the area of blockchain technology for insurance

The utilization of blockchain technology for insurance products is getting attention in Japan. In this regard, a Japanese insurance company Sompo Japan Nipponkoa Insurance has been active in applying blockchain technology to its insurance services and other financial products in collaboration with blockchain ventures, as shown in the table below.

Table 4.12 Sompo's investment in blockchain technology	
Sompo (Japan)/ Soramitu (Japan)	In 2016, Sompo announced a trial of blockchain technology for derivative products, in collaboration with Soramitsu, a Tokyo-based blockchain venture.[219]
Sompo (Japan)/ Bitfury (US)	In 2017, Sompo announced that it made an agreement with Bitfury Group in the US to apply blockchain technology to its insurance services.[220]

In 2017, Sompo joined the Blockchain Insurance Industry Initiative B3i.[221] Since its launch in October 2016, the initiative has gained broad attention across the industry and beyond, while achieving a truly global scope with additional members joining from Asia, Europe and the Americas. The current 15 members of B3i are Achmea, Aegon, Ageas, Allianz, Generali, Hannover Re, Liberty Mutual, Munich Re, RGA, SCOR, Sompo Japan Nipponkoa Insurance Inc., Swiss Re, Tokio Marine Holdings, XL Catlin and Zurich Insurance Group. In a collaborative effort, members of the B3i initiative are to explore the ability of blockchain technology to increase efficiencies in the exchange of data between reinsurance and insurance companies.

[219] The press release as of 26th September 2016 published by Sompo: http://www.sompo-hd.com/~/media/hd/en/files/news/2016/e_20160926_1.pdf

[220] The press release as of 21st November 2017 published by Sompo: http://www.sompo-hd.com/~/media/hd/files/news/2017/20171121_1.pdf

[221] The website of B3i: https://b3i.tech/home.html.

4.9 Knowledge transfer opportunities in the area of blockchain technology for HR credential management

HR (human resources) is one industry where fraud can manifest in a series of ways such as forged or altered documentation to completely fabricated documents like school credentials or previous employment records. In addition, foreign documents are sometimes mistranslated, improperly representing the original or changing the context altogether. This type of fraud is common worldwide. With blockchain technology, an institution can issue a degree to a student in a cryptographically secure, immutable, public fashion.

The table below shows two examples of corporate alliance for the use of blockchain technology in HR credential management systems.

Table 4.13 The utilization of blockchain technology in HR credential management systems in Japan

Ascribe (Germany)/ Recruit (Japan)	A Japanese recruit agency Recruit Technologies, a subsidiary of Recruit Holdings, which is a leading information services and human resources company in Japan, and Ascribe, a Berlin-based blockchain technology startup (see below), are now collaborating to bring blockchain technology to the human resources industry to increase transparency and in turn address fraud in HR credentials.[222]
Sony (Japan)/ IBM Japan (Japan)	In 2017, Sony Corporation and Sony Global Education, a subsidiary of Sony that works to provide global educational services, developed a new blockchain-based student education records platform by utilizing IBM's blockchain technology.[223] With the solution, school administrators can consolidate and manage students' educational data from several schools, as well as record and refer their learning history and digital academic transcripts with more certainty.

[222] The press release as of 26th April 2016 published by Ascribe: https://www.ascribe.io/annoucements/recruit-technologies-applies-blockchain-technology-to-the-hr-industry-through-strategic-alliance-with-ascribe/.

[223] The press release as of 9th August 2017 published by IBM: https://www-03.ibm.com/press/us/en/pressrelease/52970.wss.

4.10 Knowledge transfer opportunities in the area of blockchain technology for smart lock in the context of sharing economy

One of the promising areas for the use of blockchain technology is smart lock. In this regard, Slock.it, a German startup that is using blockchain technology to provide the smart lock systems for the emerging "sharing economy" infrastructure, has received press coverage in Japan. The table below shows how the smart lock services provided by Slock.it works.

Table 4.14 How does the system created by Slock.it work?

- When someone purchases a Slock, it will be connected to the Slock smart contract in the Ethereum blockchain and controlled by it.
- The owner of a Slock can set a deposit amount and a price for renting his property, and the user will pay that deposit through a transaction to the Ethereum blockchain (without any third party), thereby getting permission to open and close that smart lock through their smart phone.
- The deposit will be locked in the Ethereum blockchain until the user decides to return the virtual key by sending another transaction to the Ethereum blockchain.
- Then the contract will be automatically enforced. The deposit will be sent back to the user minus the price for the rental, which will be automatically sent to the owner of the Slock. All of this happens *without any assistance from a third party.*
- Cars could be parked in city roads waiting for the next customer, located with a phone application, rented by the hour and unlocked with the application by "paying the lock" in the Ethereum blockchain, used, and parked again.
- Around 2020, rental cars with smart locks could be also self-driving and pick up new customers autonomously.

The smart contract system developed by Slock.it could eliminate the need for third party intermediaries such as Airbnb and Uber in the sharing economy, empowering anyone to easily rent, share or sell anything that can be locked.

4.11 Knowledge transfer opportunities in the area of blockchain technology for E-Government services

Governments around the world have long engaged in the use of digital technologies for a variety of public services to their citizens within the context of so-called "E-Government." They are now paying attention to the utilization of blockchain technology in this respect. This applies to the Japanese government as well.

Land transaction

As mentioned in the report titled "Blockchain Technologies and Related Services" published by METI in April 2016 (see Section 4.2 above), it is possible to register, publicize, and manage information on land, such as physical status and related rights, on blockchains. Not only data on land, buildings, and owners, but also the transfer of land or other property and the establishment of a mortgage may be recorded and managed on blockchains, which will improve the efficiency of related administrative work. At the same time, the utilization of blockchain technology for land transactions may lead to diminishing the government's role to issue certificates and manage registration for land transactions.

Since early 2017, countries such as Sweden, Brazil and the Republic of Georgia have begun to utilize blockchain technology to facilitate the ownership of land properties in a decentralized, transparent and immutable network.[224] In Japan, companies such as Fujitsu[225] and Nomura Research Institute[226] have shown interest in the utilization of blockchain technology for creating a public system for land transactions.

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[224] For the information on the case in Sweden, see the report titled "The Land Registry in the blockchain – testbed" published by the international consulting agency Kairos Future in 2017: https://chromaway.com/papers/Blockchain_Landregistry_Report_2017.pdf.

[225] The article as of 5th January 2018 on the online journal Fujitsu Journal (Japanese): http://journal.jp.fujitsu.com/2018/01/05/09/.

[226] The presentation material as of 30th March 2017 submitted by NRL to the Cabinet Office of the Japanese government (Japanese): http://www8.cao.go.jp/kisei-kaikaku/suishin/meeting/wg/toushi/20170330/170330toushi13.pdf.

Medical recording

As indicated in METI's report mentioned above, it is also possible for patients to own and control their own medical data in a decentralized system where data is secured by blockchain technology. This system can be a large disruption to how medical health care data is handled today – where it is often accessible only by the doctors and hospitals themselves, and where patients have to make special requests to have a copy of their own medical records. In addition, in current systems, a parient's medical record is not easily shared between doctors. This means that patients visiting a new doctor often have to repeat their medical history all over again, or explain their current ailments.

In this regard, several initiatives have already been taken in Japan to promote the use of blockchain technology for medical recording. Examples in this regard are as follows.

- In November 2017, a group of researchers established a "Medical Blockchain Research Group" within the Japan Association of Applied IT Healthcare.[227]
- The Saga University Hospital run a pilot project in 2017 with the aim of using a blockchain-based system for the management of medical records.
- Dr. Mizushima at the National Institute of Public Health, who is also the president of the Japan Association of Applied IT Healthcare, has engaged in the research on the utilization of blockchain technology for the PHR (Personal Health Records) system.
- In April 2018, a large-scale trade event called "Healthcare IT 2018" is scheduled to be held in Tokyo, and cutting-edge healthcare systems using blockchain technology will be showcased there.[228]

On the other hand, blockchain-based initiatives for medical recording in the EU, such as the one promoted by the UK-based AI venture DeepMind in collaboration with NHS[229] and the one promoted by the UK-based blockchain venuture the Factom Foundation for medical recording,[230] have already received some media attention in Japan.

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[227] The website of the Japan Association of Applied IT Healthcare: http://www.ithealthcare.jp/.

[228] The website of Healthcare IT 2018: http://www.healthcarejapan.com/.

[229] The press release as of 27th February 2017 published by DeepMind: https://deepmind.com/applied/deepmind-health/.

[230] The press release as of 23rd April 2015 published by the Factom Foundation:

The e-Estonia initiative

Keen attention is now being paid by many Japanese key players in government, industry and academia to the Estonian government's "e-Estonia" initiative.[231] In this initiative, in collaboration with cutting-edge Estonian ventures, the Estonian government has developed a blockchain-based system that allows citizens to have access to a variety of digital public services such as e-Residency,[232] e-Health Record, e-Prescription database, e-Law and e-Court systems, e-Police data, e-Banking, e-Tax, e-Voting, and e-Land Registry.

On of the Estonian ventures that have collaborated with the Estonian government in the e-Estonia initiative is Guardtime, which is now headquarted in the Netherlands (see Table 2.7 above). Guardtime has developmed a blockchain-based system called Keyless Signature Infrastructure (KSI) as the basic infrastructure of various public service systems available for citizens within the e-Estoania initiative. KSI allows citizens to verify the integrity of their records on government databases.

Another Estonian venture that has contributed to the promotion of the blockchain system within the e-Estonia initiative is Cybernetica. Cybernetic has engated in the development of a cybsersecurity system and the e-Voting system for the e-Estonia platform. In 2018, Cybernetic reached an agreement with the Japanese data analytics company Eltes to co-develop a personal identification system for internet banking, among others.[233]

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https://www.factom.com/blog/healthnautica-factom-announce-partnership.

[231] The website of e-Estonia: https://e-estonia.com/.

[232] Estonia started the first supranational e-Residency scheme in the world in 2014. Non-Estonians around the world can join the programme and take advantage of the Estonia government's convenient digital services. The e-residents in this regard can obtain a digital ID that allows them to use Estonia's digital services online around the world. It will also give the opportunity to create a company and open a bank account in Estonia and to do business within the territory of the EU. Since 2014, more than 15,000 people from 135 countries have applied for e-residency. Finland is ranking first among the 135 countries with over 2,500 e-residents. The e-residents have already established over 1,000 new companies and more than 2,000 entrepreneurs use the e-residency to administer their businesses. The Japanese government is paying keen attention to Estonia's e-Residency system. In fact, Shinzo Abe, the Prime Minister of Japan, has already become an e-resident of Estonia.

[233] The press release as of 12th January 2018 published by Eltes (Japanese): https://eltes.co.jp/whatsnew/20180112.html.

4.12 Japanese venture capitals investing in blockchain technology

In accordance with the global blochchain momentum, Japanese venture capital funds now have strong interest in investing in blockchain ventures around the world. One example is SBI AI & Blockchain Fund.

Table 4.15 Example of blockchain-focused venture capital in Japan	
SBI Investment - SBI AI & Blockchain Fund	in 2018, SBI Investment, a subsidiary of SBI Holdings, established SBI AI & Blockchain Fund with a target commitment amount of JPY50 billion for the purpose of investing in promising venture companies in AI and blockchain fields.[234] In this regard, SBI Investment particularly notes that new technologies such as AI and blockchain are attracting global attention mostly in the financial sector, but they are also expected to be used in various other sectors, such as the medical, real estate and public sectors.

4.13 Knowledge transfer opportunities with blockchain industry associations in Japan

In Japan, there are the following two major blockchain industry associations, as shown in the table below.

Table 4.16 Major blockchain industry associations in Japan			
Name	Year of establishment	The number of members	URL
Blockchain Collaborative Consortium (BCCC)	2016	About 200 companies	http://bccc.global/en/
Japan Blockchain Association (JBA)	2014	About 110 companies and three universities	http://jba-web.jp/

[234] The press release as of 17th January 2018 published by SBI Group (Japanese): http://www.sbigroup.co.jp/news/2018/0117_10953.html.

In 2017, BCCC reached a partnership agreement with the Korean Blockchain Open Forum (KBOF).[235] Creating networks between those Japanese blockchain associations and EU blockchain industry associations may lead to providing EU blockchain ventures with opportunites to efficiently approach potential Japanese partners and investors.

4.14 Knowledge transfer opportunities with Japanese universities

There are Japanese universities that have shown interest in doing collaborative research work in the field of blockchain technology with foreign universities and companies. In this regard, in 2017, in collaboration with MIT Lab in the US, Keio University SFC and the University of Tokyo co-created a research collaboration forum called the "BASE Alliance" to facilitate an alliance with foreign as well as domestic universities and companies for research collaboration in various applied fields of blockchain technology.[236]

On the other hand, in 2017, Tokyo Institute of Technology (Tokyo Tech) made a partnership agreement with Input Output Japan, a subsidiary of the US blockchain venuture Input Output, with the aim of creating the Input Output Cryptocurrency Collaborative Research Chair within the campus of Tokyo Tech.[237]

The Blockchain Research Lab within GLOCOM (Center for Global Communications) of International University of Japan has also been active in the research on blockchain technology.[238]

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[235] The press release as of 20th December 2017: http://bccc.global/ja/articles/20171220.html.

[236] The announcement as of 24th July 2017 regarding the establishment of BASE Alliance published by Keio University: https://www.kri.sfc.keio.ac.jp/ja/press_file/20170724_base_en.pdf.

[237] The press release as of 28th February 2017 published by TIT: https://www.titech.ac.jp/english/news/2017/037573.html.

[238] The website of the Blockchain Research Lab within GLOCOM: https://blockchaineconomics.blog/.

4.15 Startup Acceleration Programs in Japan for foreign blockchain ventures

The Tokyo Metropolitan Government's initiative

Under its policy vision of the "Global Financial City: Tokyo" (see Section 3.11), the Tokyo Metropolitan Government (TMG) has been actively working to attract foreign companies to start their blockchain-based business in Tokyo. As part of this initiative, TMG is running an event called Blockchain Business Camp Tokyo, which is targeting at cutting-edge foreign blokchain ventures.[239] Only selected foreign ventures with advanced blockchain technologies can participate in the event, and they are to receive support, including mentoring, workspace, networking events, presentation opportunities for investors, and so on. The foreign blockchain ventures that have participated in Blockchain Business Camp Tokyo are mentioned in the table below.

Table 4.17 Ventures participating in Blockchain Business Camp Tokyo

- IOTA (Germany): https://iota.org/
- Xain (Germany): https://www.xain.io/
- Tempo (France): https://tempo.eu.com/en/press
- Lykke (Switzerland): https://www.lykke.com/
- Platin (Israel): https://platin.io/
- Factom (USA): https://www.factom.com/
- Gatecoin (Hong Kong): https://gatecoin.com/
- Igloohome (China): https://www.igloohome.co/

[239] The website of Blockchain Business Camp Tokyo: http://www.seisakukikaku.metro.tokyo.jp/bdc_tokyo/english/bizcamptky/blockchain.

5 Edtech (Education Technology)

5.1 The edtech boom in Japan and possible areas for knowledge transfer with Japanese counterparts

The technology for education or "edtech" refers to a variety of digital technologies for facilitating learning in various subjects. Now in Japan, a growing number of edtech ventures have been created, and large education companies have been active in investing in or partnering with cutting-edge edtech ventures, in order to respond to ever growing demands for digital education tools in a variety of subjects.

A glimps of the edtech boom in Japan can be caught in a report published in 2016 by Yano Research Institute regarding the growing trend of e-learning business in Japan.[240] According to this report, the domestic e-learning market in FY 2016 is estimated to have reached JPY 176.7 billion, 106.7% up compared with the previous year. Out of that number, JPY 117 billion is for the B-to-C market, whereas JPY 59.7 billion is for the B-to-B market. The area of edtech is not the same as that of e-learning but they overlap with each other to some extent.

In line with the edtech momentum, an increasing number of Japanese venture capitals now invest in edtech ventures. For example the Japanese venture capital EduLab has actively invested in foreign as well as Japanese edtech ventures.[241] In 2016, EduLab invested in Elsa, a US-based venture that has developed Elsa, a mobile application based on AI-based speech recognition technology for English learners to correct their pronunciation (see Table 5.6 below). Other foreign edtech companies or edtech-focused venture capitals Edulab has invested in include Authess (US), LearnLaunch (US), Listenwise (US), Fresco Caiptai (US), Codemonkey Studios (Israel), and SpeakingPal (Israel), among others.

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[240] Yano Research Institute, *e-Learning Market in Japan: Key Research Findings 2017* (Japanese). Available at: file:///Users/torukodama/Downloads/1677.pdf.

[241] The website of EduLab: http://edulab-inc.com/en/.

In accordance with this booming edtech trend in Japan, chances for EU edtech entities to conduct knowledge transfer with Japanese counterparts are growing, especially in relation to the four areas mentioned in the table below.

Table 5.1 Possible edtech areas for knowledge transfer from EU entities to Japanese counterparts

- Edtech for computer programing as part of STEAM (Science, Technology, Engineering, Arts and Mathematics)
- Edtech for English language learning
- Online education platform
- VR/AR technologies for education and vocational training

5.2 Knowledge transfer opportunities in the area of edtech for computer programing education as part of STEAM

STEAM for the realization of "Society 5.0"

Generally speaking, STEAM (Science, Technology, Engineering, Arts and Mathematics) programs aim to teach students to think critically and creatively, and to have an engineering or design approach towards real-world problems while building on their math and science base. The concept of STEAM has emerged by integrating the importance of art and design skills into the pre-existing concept of STEM (Science, Technology, Engineering and Mathematics). And, computer programing education is considered to be a vital element of STEAM.

Teaching students how to write a code as part of formal educational programs has been a vital policy agenda in countries embracing IT. For example, Israel now enjoys the reputation as "Startup Nation" or "Cyber Nation," celebrating the success of its innovation-driven high-tech economy. Much of the credit for today's thriving knowledge economy in Israel can be given to that country's education system for computer programing.[242] In the US, within the framework

[242] Daniel Estrin, "In Israel, teaching kids cyber skills is a national mission," 4th February 2017, *The Times of Israel*. Available at: https://www.timesofisrael.com/in-israel-teaching-kids-cyber-skills-is-a-national-mission/.

of the Computer Science for All Initiative,[243] President Barack Obama invested USD 4 billion in the computer science education.

The Japanese government has been increasingly aware of the necessity of STEAM programs incorporated into public education systems. In fact, the Japanese government has decided that computer programming will be made a compulsory subject in the Japanese primary schools in 2020. It will be followed by the implementation in middle schools in 2021 and high schools in 2022. The goal is to secure workers who can support the so-called fourth industrial revolution or the Japanese government's vision of "Society 5.0." Now the edtech market for computer programming learning is rapidly growing in Japan.

European edtech companies that have entered the Japanese edtech market

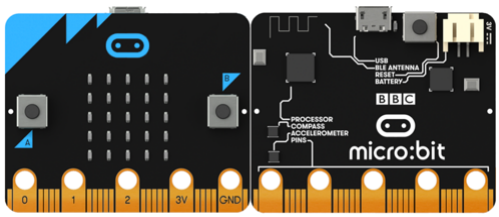
There are several European edtech companies providing computer education products in the Japanese market. The table below indicates three examples of such companies.

Table 5.2 Examples of European edtech companies doing business in Japan

Cubetto (UK)	In 2016, Primo Toy, a UK-based developer of computer programing education software, started selling its product named Cubetto in the Japanese market. Cubetto is a wooden cube that teaches three-year-olds and over to code without using a screen. The cube conceals a customised computer that connects via Bluetooth to a wooden interface board.  Photo from Cubetto's website.[244]

[243] For the information on this initiative, see the website of the White House: https://obamawhitehouse.archives.gov/blog/2016/01/30/computer-science-all.

[244] Available at: https://www.primotoys.jp/.

	Children control Cubetto's movements by slotting colourful blocks into the interface board, thereby creating basic algorithms and programs. Each shaped block represents a specific command for Cubetto—move left, right, forward or backwards. A separate function block acts as a shortcut command for a longer sequence of movements laid out in another part of the board. The system is tactile and can be operated by blind children. The process is also intuitive and non-verbal, so the robot has cross-border cultural appeal.
Micro Bit (UK)	In 2017, Switch Education, a Japanese education service venture, started selling in the Japanese market a product named Micro Bit, which is a British software product that was developed by BBC (British Broadcasting Corporation) for computer program learning for kids.[245]  Photo from Micro Bit's website.[246]
Lego (Denmark)	Lego Japan, the Japan-based subsidiary of Danish company Lego, has been involved in programming education for long time in Japan and has already released the WeDo 2.0 robotics kit for elementary school students to learn computer programing in an effective way. With a tablet-based interface, the kit teaches kids how programming works by using basic robotics apps. Children can assemble their own robots using Lego blocks and small motors. Through the learning software, they can program how their robots move simply by placing colored panels on the screen.  Photo from Lego Japan's website.[247]

[245] The press release as of 25th July 2017 published by Switch Education (Japanese): https://switch-education.com/2017/07/25/microbit_launching_in_japan/.

[246] Available at: http://microbit.org/ja/guide/.

[247] Available at: http://www.legoedu.jp/wedo2/.

An interesting pilot project for computer programing education is the government-sponsored "ICT Dream School Project," where students learn computer programing by using the combination of Minecraft, which was originally developed by Swedish venture Mojang, and the 3D printing software developed by the Japanese venture Kabuku.

Table 5.3 The ICT Dream School Project in Japan

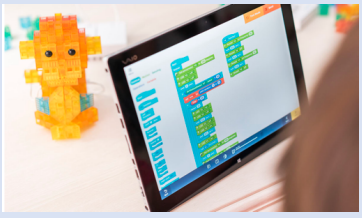
Minecraft (originally from Sweden)	Microsoft Japan, the Japan-based Microsoft subsidiary, has teamed up with Japanese 3D printing service provider Kabuku for a pilot tutorial project that aims to introduce students to basic coding concepts and digital fabrication using Minecraft. Minecraft is a game software product that was developed by a Swedish game developer Mojang, which was later acquired by Microsoft. The pilot program is a test case for the course titled "Digital House Making" in the ICT Dream School Project, which is to be promoted by the Ministry of Internal Affairs of the Japanese government from 2014 to 2019. This course is offered to grade sixth students from an elementary school in Tokyo. In this course, students design and build their own building or structure by plaing the Mincraft game, and simply send the building data off to be 3D printed as duplicates of the designed Minecraft structure. For this purpose, Kabuku incorporated the Rinkak Avatar 3D printing application into the Minecraft game. The purpose of this course is for students to use the familiar game language of Minecraft to learn more about basic coding and 3D printing technology. Having a 3D printed copy of their Minecraft building makes it easier for students to understand how programming and coding is used to build virtual objects.  Source: Rinkaku's website.[248]

[248] Available at: https://www.rinkak.com/us/news/minecraft_ict-dream-school?hl=ja.

Examples of American and Chinese edtech ventures entering into the Japanese market in the area of computer programing education

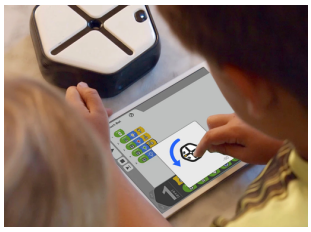
The Japanese market in the field of computer programing education is increasingly competitive, while ventures from other countries such as the US and China are now entering into the market in collaboration with their Japanese counterparts, as can be seen in the table below.

Table 5.4 Examples of American and Chinese edtech ventures entering into the Japanese market in the area of computer programing education

Sony Electronics (US)	Sony Electronics is a subsidiary of Sony Corporation of America and an affiliate of Sony (Japan), one of the most comprehensive entertainment companies in the world. In 2018, Sony Electronics unveiled the KOOV Educator Kit, an all-in-one coding, robotics and design kit that combines digital coding with physical building to teach the next generation of innovators.[249] KOOV is made up of over 300 building blocks and accessories, along with a plethora of sensors, motors, LEDs and more. The KOOV Educator Kit includes the KOOV App, which features more than 30 hours of easy-to-follow educational content via its Learning Course. The KOOV Learning Course offers a great starting point for students to begin learning key concepts in coding, building and design. This educational course introduces the different electrical components that KOOV uses and provides students an overview of how those parts work and how to use Scratch-based coding to control them.  Photo from the website of Sony Electronics.[250]

[249] The press release as of 15th February 2018 published by Sony Electronics: https://www.sonyged.com/2018/02/15/news/press_educator_kit_en/.

[250] Ibid.

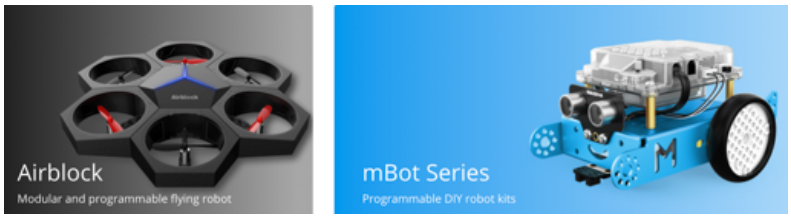
Root Robotics (US)/ Dream Incubator (Japan)	In 2017, Dream Incubator, a Japanese venture capital and business consultancy, invested USD 2.5 million, together with three other investors, in Root Robotics, the US-based venture that was founded by CEO Zee Dubrovsky (formerly with Sonos, iRobot, Wyss Institute), CTO Raphael Cherney (formerly with Apple, Microsoft, Wyss Institute), and Harvard University computer science Professor Radhika Nagpal.[251] Root Robotics produces education robots named Root that teach students at any level real coding skills with an engaging progression of lessons from blocks based graphical interfaces to career-based languages.  Photo from the website of Root Robotics.[252]
Neuron Fuel (US) / Dentsu (Japan)	In 2016, Dentsu (see Section 6 "Martech" of this report) invested in Neuron Fuel, the US-based venture that runs an educational programming platform named Tynker that is aimed at teaching kids how to make games and programs.[253]  Photo from Tynker's website.[254]
Makeblock (China)/ SoftBank (Japan)	Since 2017, SoftBank has been in partnership with Makeblock, a fast-growing maker of DIY robotics for computer programing education in

[251] The press release as of 9th August 2017 published by Dream Incubator: http://www.dreamincubator.co.jp/wp/wp-content/uploads/2017/09/Root-Robotics_PR.pdf.

[252] Available at: http://www.codewithroot.com/.

[253] The press release as of 2nd August 2016 published by Dentsu (Japanese): http://www.dentsu.co.jp/news/release/2016/0802-008995.html.

[254] Available at: https://www.tynker.com/?t=reset.

	China, where STEAM education is tapping into Chinese parents' craze for their children to learn coding and robotics. Makeblock is backed by Sequoia Capital, one of the world's most famous IT venture capitals. Under the partnership scheme, SoftBank distributes Makeblock's educational robot products for computer programing in the Japanese market.  Photo from Makeblock's website.[255]

5.3 Knowledge transfer opportunities in the area of edtech for English language learning

Strong demand for English language learning edtech

Although Japan has long been reputed for being the birthplace and homeground of many global companies, Japanese people's poor English skills are world-famous. According to the Education Testing Service, which administers TOEFL, out of 30 Asian countries with TOEFL examinees in 2015, Japan ranked fifth from the bottom, ahead of Afghanistan, Cambodia, Tajikistan and Laos. South Korea, where English became a mandatory subject in elementary school in 1997, ranked 10th. China, which followed suit in 2001, ranked 17th.

The Japanese government has now been increasingly worried that the poor English skills of the Japanese people may lead to undermining the international competitiveness of the country's industry. In the World Economic Forum's annual Global Competitiveness Index 2017-2018 of 137 countries and regions, Japan is ranked 9th, down one place from last year's assessment.[256] Japan saw its ranking drop for the second consecutive year. The Japanese government has also been concerned that this situation may result in the downgrading of the international

[255] Available at: http://www.makeblock.com/.

[256] Available at: http://reports.weforum.org/global-competitiveness-index-2017-2018/competitiveness-rankings/.

competitiveness of the Japanese academia. In fact, one of the reasons why top-tier Japanese universities have continued to fall in the World University Rankings published by Times Higher Education is that Japanese universities have fewer researchers who publish "English" treatises worthy of being cited by many of their peers in their relevant fields around the world.[257]

Under these circumstances, the Japanese government has decided that, in 2020, English will become a mandatory subject for fifth- and sixth-graders at elementary schools, instead of a "foreign language activity" class where children are only expected to experiment with English by speaking and listening. This will double the annual number of English classroom hours to 70 from the current 35, and see reading and writing taught to children for the first time.

At the same time, an increasing number of Japanese companies have introduced TOEIC (Test of English for International Communication) requirements for job applicants. In 2016, 2.7 million people took the TOEIC examination. The number of Japanese universities that have obliged students to take TOEFL, instead of traditional English language tests focusing heavily on reading and writing rather than listening comprehension or conversational skills, in their entrance examination processes, is also increasing.

The table below shows possible fields of edtech for English learning in terms of knowledge transfer with Japanese counterparts.

Table 5.5 Possible fields of edtech for English learning in terms of knowledge transfer with Japanese counterparts

- AI-based edtech for English learning
- Edugame technology for English learning
- Online English speaking courses

[257] *The Japan Times*, the online article "Why Japan's universities continue to fall in global rankings" as of 24th December 2017. Available at: https://www.japantimes.co.jp/opinion/2017/12/24/commentary/japan-commentary/japans-universities-continue-fall-global-rankings/#.WrZIvdPFIgo.

AI-based edtech for English learning

In recent years, AI and deep learning technologies have started to be applied actively in the field of education. Especially in the area of language education, demands are growing for learners to have an environment where they can take effective lessons using an AI-based interactive tool that matches their learning progress. In this regard, Sinewave, a Japanese AI venture, has started delivering an AI-based edtech application for English learning called "SiF" in the Japanese market.[258] On the other hand, several foreign ventures have entered into the Japanese market with their AI-based edtech for English learning.

Table 5.6 Examples of foreign edtech ventutes that have entered the Japanese market in the area of AI-based edtech for English learning

AKA (US)/ SoftBank (Japan)	SoftBank has started selling a AI-based robot product for English learning named "Musio X" in the Japanese market. Musio X was developed by AKA, a US-based AI venture.[259] Musio X has now been used as a edtech tool for English learning at a junior high school in the Saitama Prefecture of Japan.   Photo from the website of PR Time.[260]
Elsa (US)/ EduLab (Japan)	In 2016, EduLab, a Japanese venture capital focusing on edtech (see Section 5.1), invested in Elsa, a US-based venture that has developed Elsa, a mobile application based on AI-based speech recognition technology for English learners to correct their pronunciation.[261] Under this partnership, EduLab is to support the further

[258] The website of Sinewave (Japanese): https://www.sinewave.co.jp/.

[259] The website of AKA: http://akaintelligence.com/.

[260] Available at: https://prtimes.jp/main/html/rd/p/000000050.000022656.html.

[261] The press release as of 22nd June 2016 published by EduLab (Japanese): http://edulab-inc.com/press-

	development of Elsa's AI-based speech recognition technology and the marketing of that technology in the Asian region.  iPhone screenshots of Elsa from the website of iTunes.[262]
Cooori (Iceland)	Cooori, a venture from Iceland, has been expanding its AI-based online English learning services in the Japanese market.[263]

Edugame technology for English learning

One of the most important essences in edtech is its mechanism to motivate people to learn. In this regard, the concept of educational games or "edugames" has recently gained particular attention. Edugames are games that are designed to help people to learn about certain subjects, based on the "gamification" concept, which is the concept of applying general game design theories to engage and motivate people to achieve certain goals. It comes down to defining small steps and giving the players a feeling of achievement to make them progress through the flow. To integrate these gamification concepts into the learning process has a far-reaching potential in the edtech area. Edugames typically apply a mix of video game design and game elements in learning environments to motivate the students to learn.

The concept of edugame has recently been applied into edtech for English language learning programs, especially those for kids. A good example of European edugame technology for English learning that is getting popular in Japan is Lingokids:

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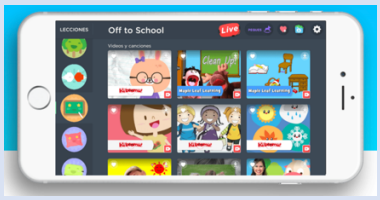
release/20160622.html.

[262] Available at: https://itunes.apple.com/us/app/elsa-speak-learn-to-speak/id1083804886?mt=8&ign-mpt=uo%3D4.

[263] The website of Cooori: https://www.cooori.com/.

Table 5.7 Example of European edugame technology that is gaining attention in Japan	
Lingokids (Spain)	An English learning edugame product named Lingokids, which is made by Spanish venture Lingokids, is getting popular in Japan. Lingokids is an English learning application for kids ages 2 to 8, and the lessons in the application are built using the gaming and entertainment platform Unity3D and run on Android and iOS.  Photo from Lingokids' website.[264]

Online English speaking courses

Many companies have provided online English learning services in Japan. One notable example of growing companies in this field is Rarejob. Rarejob was established in 2007, and has now grown, with more than 400,000 subscribers, to be one of the largest online English language learning service companies in Japan. Rarejob's Skype-based English language learning lessons with teachers in the Philippines has been increasingly popular since 2010.

There are many other companies providing online English language learning lessons in Japan, examples of which are mentioned in the table below. Due to the growing competition among the players in the Japanese market, the fees per lesson have been decreasing steadily, and the recent years have seen many M&A or corporate alliance cases among several players for them to survive this severe competition.

Table 5.8 Examples of online English speaking courses in Japan
▪ NativeCamp: https://nativecamp.net/ ▪ EF EnglishLive: https://englishlive.ef.com/ja-jp/lp/os/online-native-english/ ▪ Kimini: https://glats.co.jp/lp/01/ ▪ Langrich: http://www.langrich.com/

[264] Available at: https://www.lingokids.com/english-for-kids.

5.4 Knowledge transfer opportunities in the field of online education platforms

One of the strong driving forces behind the expanding edtech market is the activities of "platformers" for creating a platform to deliver online educational contents, sometimes through corporate alliances as mentioned in the table below.

Table 5.9 Examples of corporate partnerships for co-promoting online education platforms

Quipper (UK)/ Recruit (Japan)	Founded in 1963, Recruit has been one of the largest publishing companies, and has recently been active in establishing a strong foothold in the edtech market. In 2015, Recruit purchased for USD 40 million the UK-based firm that runs a platform of digital education contents.[265] Quipper was founded in 2010 in London by one of the founders of DeNA, a Japanese company which runs one of the most popular cell phone gaming platforms in Japan. Online learning contents on the Quipper platform are provided by teachers, experts, publishing houses, teachers and others. Quipper now has offices at five locations worldwide, including London, Tokyo and Manila. Quipper has expanded into emerging markets like Indonesia, Mexico and the Philippines where schools typically lack teachers yet want to provide sufficient learning opportunities for their students. A total of about 3 million people in the world have subscribed to Quipper's online courses.
Benesse (Japan)/ SoftBank (Japan)	Benesse is the largest private education service provider in Japan, operating the country's largest private correspondence courses for more than 3.6 million Japanese children. In 2014, Benesse, together with SoftBank, established a company named Classi to provide a platform for online educational courses.[266] Classi combines SoftBank's cloud technology, tablet devices and network environment structure, and Benesse's strength in the B-to-C education market and wide education contents line-up. Classi has contents from major publishers

[265] The website of Quipper: https://www.quipper.com/.

[266] The website of Classi: https://classi.jp/.

	including Gakken. At the moment, they already have more than 10,000 educational contents available on the Classi website.
Udemy (US)/ Benesse (Japan)	In 2015, Benesse reached a partnership agreement with Udemy, US-based leading global marketplace for online education contents. Under the partnership, Benesse has delivered to the Udemy market place more than 100 online courses regarding a wide range of topics from technical skills and vocational training to language, general lifestyle and hobby courses.[267]

On the other hand, Japan Open Online Education Promotion Council (JMOOC), a non-profit organization that provides MOOC (Massive Open Online Courses) under the cooperation of Japanese universities, currently features three official platforms: Gacco, which is offered by NTT Docomo and NTT Knowledge Square; OpenLearningJapan, which is offered by NetLearning; and OUJ MOOC, which is offered by the Open University of Japan.[268] In 2016, the online JMOOC courses provided in these platforms have reached 500,000 people in total. Most of those courses are offered for free and targets primarily at students, homemakers and senior citizens, while certain fees might be applicable for more advanced contents.

5.5 Knowledge transfer opportunities in the field of VR/AR technologies for education

How to utilize virtual reality (VR) and augmented reality (AR) for various educational activities and vocational training has recently been a very hot topic in Japan. (For the information on VR/AR technologies, see Section 7.4 of this report.) The benefits of incorporating VR/AR technologies into educational experiences include better, more immediate engagement and the opportunity for learners to feel the experiences and better remember and express what they learned. The more a learner is able to participate in life-like engagement, the easier it is to personally feel a connection to the subject material, making it easier for application and retention of the subject matter. Ultimately, VR/AR in education will revolutionize not only how people learn but how they interact with real-world applications of what they have been taught.

[267] The website of Udemy: https://www.udemy.com/.

[268] The website of JMOOC: https://www.jmooc.jp/.

Increasing use of VR/AR for vocational training in Japan

The most popular trend in VR/AR learning in Japan can be seen in industry. For example, the Japanese security company SECOM has adopted the security training program for its employees that is based on the VR technology developed by the Japanese VR/AR venture Kadintche.[269]

Photo from the website of SECOM.[270]

Other examples of the use of VR/AR for vocational training are as follows.

- The Japanese nursing care service company Human Life Care has adopted the nursing care training program for its employees that is using VR-based educational contents.[271]
- JR East, one of the largest passenger railway companies in Japan, has adopted the VR-based training program for its employees engaging in the construction work at its railways.[272] The VR technology used in this program is provided by the Japanese VR/AR venture Tsumiki Seisaku.[273]
- The Japanese building construction company Tokyu Construction has adopted the VR-based security training program for its employees engaging in the construction work at construction sites.[274] The VR technology used in this program is provided by Bandai Namuko, one of Japan's largest game developers.

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[269] The press release as of 6th November 2017 published by Secom (Japanese): https://www.secom.co.jp/corporate/release/2017/nr_20171106.html.

[270] Ibid.

[271] The press release as of 18th October 2017 published by Human Life Care (Japanese): http://www.athuman.com/news/2017/171018_hlc_vrtraining/.

[272] The online article as of 13th September 2017 on the website of *PR Times* (Japanese): https://prtimes.jp/main/html/rd/p/000000004.000024673.html.

[273] The website of Tsumiki Seisaku: http://tsumikiseisaku.com/.

[274] The news release as of 24th August 2017 published by Tokyo Construction (Japanese): http://www.tokyu-cnst.co.jp/index/download/2922/inline/20170824VR.pdf.

At the same time, the high potentiality of VR/AR technologies as a tool for various medical training, including surgical training, is recently increasingly capturing attention in Japan. Dr. Maki Sugimoto, Associate Professor at International University of Health and Welfare, has been a key person in this respect, having developed various VR-based medical education tools in this regard. He is also working as CTO at the Japanese venture Holoeyes, which is developing a surgical operation system using VR technology.[275]

VR/AR research hubs in Japan

In the Japanese academia, a growing number of researchers at major Japanese universities have engaged in the research on the utilization of VR/AR technologies for various purposes, including educational purposes. The following is a list of three major Japanese universities' VR/AR labs. They can surely be good partners for VR research institutes in the EU.

Table 5.10 Major Japanese universities' VR/AR research labs

- University of Tsukuba
  - Virtual Reality Laboratory: http://intron.kz.tsukuba.ac.jp/
- The University of Tokyo
  - Cyber Interface Laboratory: http://www.cyber.t.u-tokyo.ac.jp/ja/
- Keio University
  - Tachi Laboratory: http://tachilab.org/

Japan's largest academic association in the VR/AR technology field is the Virtual Reality Society of Japan.[276] Japanese Society for Medical Virtual Reality is the major academic society that consists of researchers engaging in the application of VR/AR technology for medical purposes.[277]

[275] The website of HoloEyes: http://holoeyes.jp/.

[276] The website of the Virtual Reality Society of Japan: https://vrsj.org/.

[277] The website of Japanese Society for Medical Virtual Reality: http://www.jsmvr.umin.ne.jp/about/

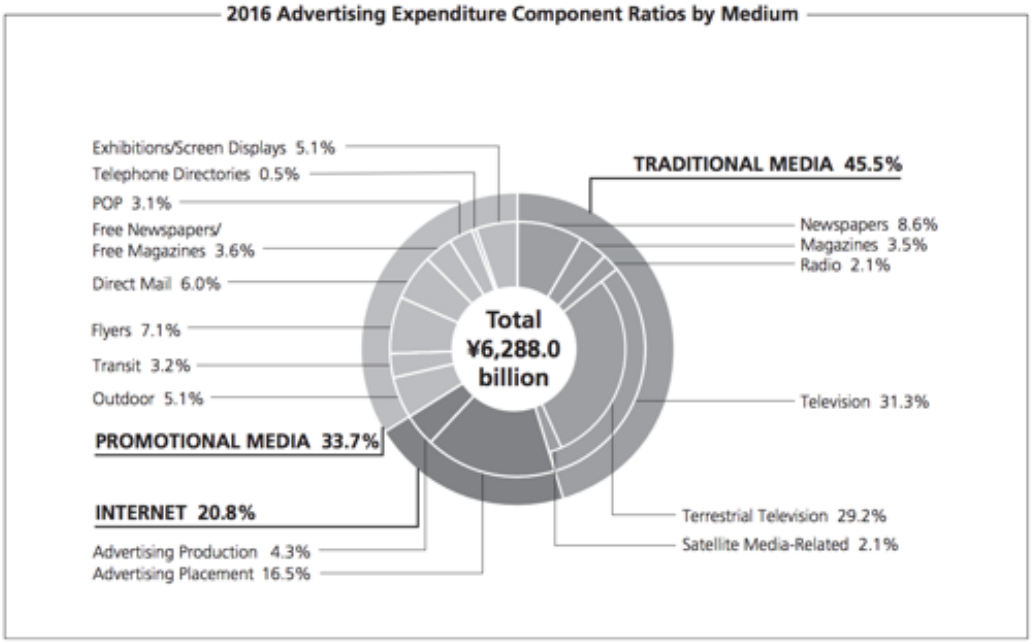
6. Martech (Marketing Technology)

6.1 The advertising market in Japan

In today's advertising world, marketing technology or "martech" generally means a digital online technology for a variety of marketing purposes, including insight from marketing data, online traffic prediction analysis, customer behavior analysis, user experience analysis, recommendation engines, content generation, advertisement placement, and so on.

In line with the constant growth of the internet advertising market, business chances for martech ventures have been rapidly increasing around the world. Japan is no exception. According to the report titled "Advertising Expenditures in Japan 2016,"[278] Japan's advertising expenditures for 2016 totaled JPY 6,2 trillion, of which Internet advertising makes up JPY 1.3 trillion (13.0% up compared with that of 2015).

Figure 6.1 2016 Advertising Expenditure Component Rations by Medium



Source: Dentsu, Advertising Expenditures in Japan 2016.

[278] Dentsu, 2016, *Advertising Expenditures in Japan*. Available at: http://www.dentsu.com/knowledgeanddata/ad_expenditures/pdf/expenditures_2016.pdf.

Internet advertising expenditures accounted for 20.8% of spending in all media, a rise of 2.0 percentage points compared with the figure for 2015. The shift to Internet media continued in Japan, as spending on Internet media exceeded JPY 1 trillion for the first time. Also, the mobile ad market has emerged as an important part of the Internet advertising in Japan.

In the Japanese ad market, Dentsu and Hakuhodo are the two overwhelmingly dominant advertising agencies. CyberAgent can be a rival against Dentsu and Hakuhodo in the Japanese Internet ad market but still behind the two giants. Opt and Septeni are in the second group in the Japanese Internet ad market.

In view of the expanding Internet ad market in Japan, several European martech firms have recently established their branch offices in Tokyo and been providing their martech-based services to Japanese clients.

Table 6.1 Examples of European martech companies doing business in the Japanese market

Company name	Martech area	URL regarding Tokyo office
Teads (France)	Outstream video advertising (see below)	https://teads.tv/jp/
Criteo (France)	Online retargeting (see below)	https://www.criteo.com/jp/
Syno (Lithuania)	Digital marketing analytics	http://www.synoanswers.com/en/about-us
Tobii (Sweden)	Online eye tracking (see below)	https://www.tobiipro.com/ja/
Unruly (UK)	Outstream video advertising + emotion analysis (below)	https://unruly.co/tag/unruly-japan/
Ve (UK)	Digital marketing analytics	https://www.ve.com/ja/about-us

6.2 Advanced martech tools as a driving force behind the growth of Internet advertising in Japan

One of the key factors contributing to the high performance of Internet advertising is the rapid development of advanced martech tools. The table below provides brief information on four edtech tools that have captured much attention in the Japanese Internet advertising market.

Table 6.2 Brief information on technologies for outstream video advertising, emotion analysis, re-targeting, and online eye tracking	
Outstream video advertising	An "outstream" video ad unit is a new video advertising unit that automatically plays in a large format player whenever a user navigates to it within text content (typically an article), even if the publisher does not have their own video content. It is called outstream because the video ad exists outside of online video content – also known as "instream" video content — where the ad plays either before (pre-roll), during (mid-roll), or after (post-roll) the publisher's video content on YouTube, Facebook or any other online platform. The largest advantage of outstream video ads is the immense scope of ad placement. Ad placements are not limited to existing videos and their content. The ads can be placed anywhere and everywhere. On the other hand, the largest disadvantage of instream video adds is the limited scope for ad placement. Instream video ads can only be run within existing videos.
Emotion analysis	The technology provided by Unruly (see above) named "Unruly EQ" uses a combination of biometric, neurological, emotional and audio testing methods to evaluate, improve and predict the emotional, social and behavioral triggers that drive the viral success of the video ads of advertisers. Unruly Japan has engaged in the collaborative research with Keio Business School in Japan in this emotion analytics technology field.[279] In collaboration with Microsoft Japan, Hakuhodo (see below) has developed a technology named Face Targeting AD, which is an emotion analytics technology for analyzing viewers' emotional conditions from their facial expressions and selecting an appropriate advertisement in response to those emotional conditions.[280] AI technology for emotion recognition or emotion detection will be increasingly utilized for marketing purposes in this regard.

[279] The press release as of 11th November 2015 published by Unruly: https://unruly.co/news/article/2015/11/11/video-ad-tech-company-unruly-launches-new-algorithmic-tool-to-predict-emotional-impact-of-japanese-ads/.

[280] The press release as of 9th March 2017 published by Hakuhodo (Japanese):

Re-targeting	The re-targeting technology provided by Criteo (see above) is a form of display advertising that enables online businesses to follow up visitors who have left their website without making a purchase using personalized banners which aim to drive potential customers back to the business website.
Eye tracking	The eye tracking provided by Tobii (see above) is a tool to objectively measure consumers' attention and spontaneous responses to marketing messages. Knowing what people actually see helps advertisers optimize the design and placement of ads. Fujitsu has also developed the online eye tracking technology named "EyeExpert."[281]

6.3 Knowledge transfer opportunities with Dentsu and Hakuhodo

Dentsu and Hakuhodo as the top priority targets for EU martech ventures' knowledge transfer strategies

In the Japanese advertising market, Dentsu and Hakuhodo have been the overwhelmingly dominant forces for a long time. They are not only a huge advertising agency but also a cutting-edge edtech company. Most of Japan's large corporations are their clients. There are other advertising agents in Japan, and an increasing number of Japanese martech ventures have been created during the past few years. However, the investment capacity of Dentsu and Hakuhodo overwhelms that of the rest of Japan's advertising agencies and martech firms. And, they have a large number of martech experts within their organizations who have sophisticated insight into the state-of-the-art technology developments in the global martech market. One exception is CyberAgent, which has been active in investing, especially through its venture capital arm CyberAgent Ventures in Silicon Valley, in foreign ventures, including URX (US),[282] AnyPerk (US),[283] and Dash Labs (US).[284]

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http://www.hakuhodo.co.jp/archives/newsrelease/37109.

[281] See the website of Fujitsu regarding EyeExpert (Japanese): http://www.fujitsu.com/jp/group/fct/products/eyeexpert/.

[282] The press release as of 23rd October 2013 published by CyberAgent (Japanese): https://www.cyberagent.co.jp/news/press/detail/id=8064.

[283] The press release as of 24th June 2014 published by CyberAgent (Japanese): https://www.cyberagent.co.jp/news/press/detail/id=9037.

[284] The press release as of 5th March 2014 published by CyberAgent (Japanese):

Therefore, it is important for EU martech ventures, when considering their alliance strategy for Japanese advertising agencies, to put their priority on how to strategically approach Dentsu and Hakuhodo, and to realize what martech tools they are targeting at as key technologies for their global clients.

Corporate clients of Dentsu and Hakuhodo have been increasingly globalized, so the activities of Dentsu and Hakuhodo have also expanded globally. And, digitalization and globalization have made the marketing activities that companies carry out more complex and sophisticated world-wide, spurring innovation in marketing methods and the development of new solutions. Dentsu and Hakuhodo have been under tremendous pressure to quickly respond to any technological developments in the martech field so that they can satisfy almost any demands from their corporate clients for the furtherance of their marketing activities in the global market. To respond to these challenges, Dentsu and Hakuhodo have been very active in investing in or partnering with cutting-edge foreign ventures in a diverse range of martech areas around the world.

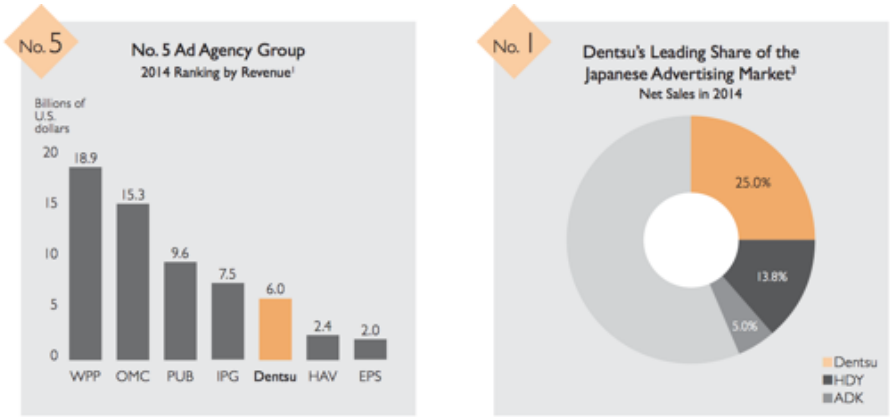
Overseas expansion of Dentsu's business

Dentsu is Japan's largest advertising agency, and currently has a 25% share of the advertising market in Japan, and is currently the 5th largest advertising agency in the world in terms of worldwide revenues.[285]

https://www.cyberagent.co.jp/news/press/detail/id=8533.

[285] Dentsu, *Dentsu Annual Report 2015*. Available at: http://www.dentsu.com/ir/data/annual/2015/dwl/pdf/EAR_ALL.pdf.

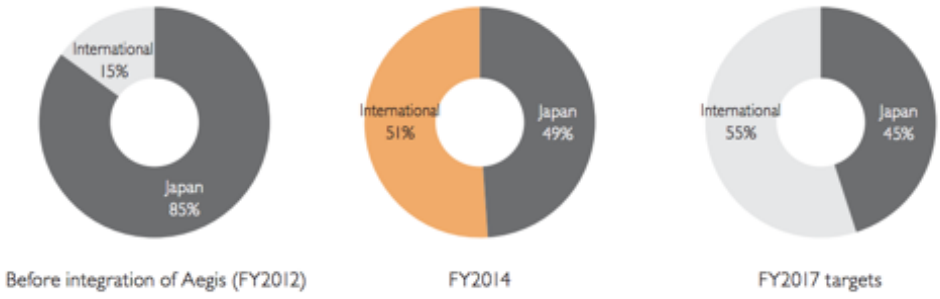
Figure 6.2 Dentsu's strength in the global as well as domestic advertising markets



Source: Dentsu, Advertising Expenditures in Japan 2016.

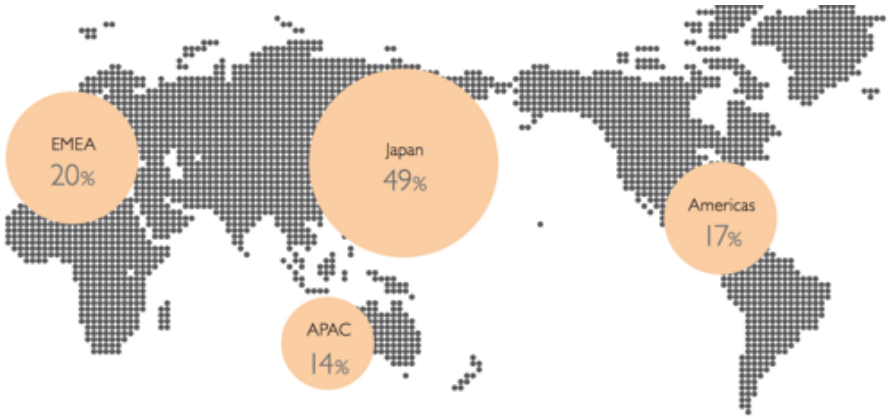
In 2013, Dentsu bought Aegis Group, a UK-based large advertising conglomerate and formed its global business headquarters named "Dentsu Aegis Network" to invest in martech ventures around the world. With the acquisition of Aegis Group in 2013, the international aspect of Dentsu Group's gross profit has expanded significantly, and its business structure has become much more regionally diverse. Dentsu's global business currently operates with 380 offices and 43,000 employees in 124 countries around the world. In terms of percentage mix by major region, Japan accounts for 49%; EMEA (Europe, Middle East and Africa), 20%; the Americas (North, Central and South America), 17%; and APAC (Asia Pacific/ excl. Japan), 14%.

Figure 6.3 Dentsu's expansion of its business in the global advertising market (1)



Source: Dentsu, Advertising Expenditures in Japan 2016.

Figure 6.4 Dentsu's expansion of its business in the global advertising market (2)



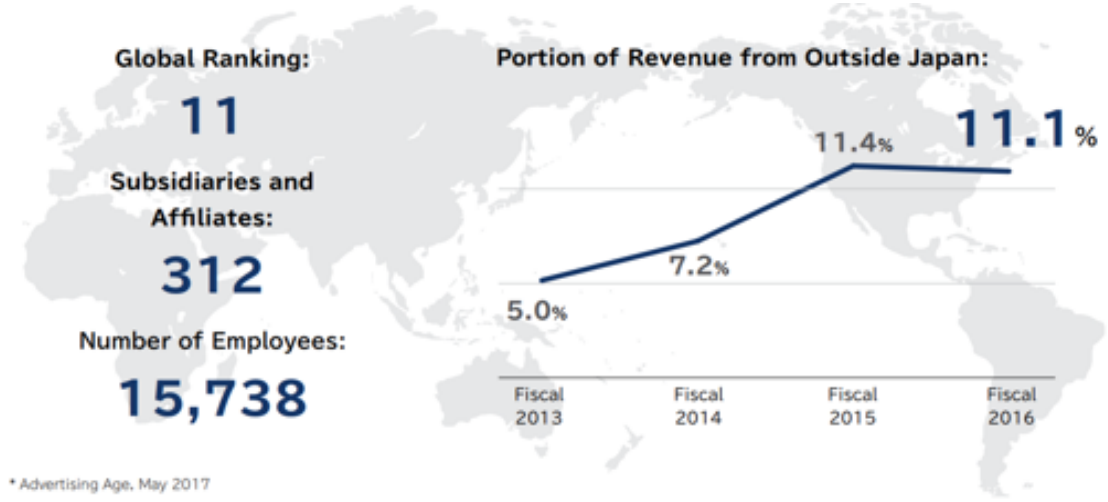
Source: Dentsu, Advertising Expenditures in Japan 2016.

Dentsu Digital and ISID (Information Services International-Dentsu), two subsidiaries of Dentsu, together set up the Dentsu Digital Marketing Technology Center as a cross-group organization with approximately 200 specialists in the areas of marketing system integration and data/technology utilization in 2017. It is still difficult, however, for Dentsu to catch up with rapidly developing martech fields and to respond to all the demands from its global corporate clients with its own in-house capacity. This has strongly motivated Dentsu to invest in or ally with foreign martech ventures, including many EU martech companies.

Overseas expansion of Hakuhodo's business

Hakuhodo is the second-largest advertising company in Japan. Until 2002 the company trailed behind its larger rival, less than half Dentsu's size. That year Hakuhodo engineered a merger with two other Japanese agencies, Daiko and Yomiko, to create Hakuhodo DY Holdings, in order to narrow the gap with Dentsu. Today, the Hakuhodo DY Group is the No. 2 advertising group in Japan and No. 11 in the world. As of March 31, 2017, the Hakuhodo DY Group consists of 312 subsidiaries and affiliates around the world with a combined total of 15,738 employees, and 11.1% of total revenue was generated overseas in fiscal 2016.

Figure 6.5 Hakuhodo's strategy for the global advertising market



Source: Hakuhodo DY Holdings Annual Report 2017[286]

Under the Medium-Term Business Plan, Hakuhodo aims to increase overseas revenue to account for 20% of total revenue by fiscal 2018, and is expected to conduct proactive investment in cutting-edge market ventures around the world.

Examples of knowledge transfer from foreign martech ventures with Dentsu and Hakuhodo

The table below shows examples of Dentsu's investment in or alliance with EU martech ventures.

Table 6.3 Examples of European martech companies Dentsu has invested in

Corporate Name	Year of investment	Activity area
media.at (Austria)	2017	media.at is a media agency providing full-services including consulting, research and data analysis related to communications strategy, advertising planning and buying for the traditional media (newspaper, magazine, radio and television), digital, OOH (outdoor and transit) and other media, and the verification of

[286] Available at: http://v4.eir-parts.net/v4Contents/View.aspx?template=ir_material_for_fiscal_ym&sid=38380&code=2433.

		advertising efficacy as well as other services.
Magnetix (Denmark)	2016	Magnetix is a leading digital agency in Denmark by creating new standards for customer relations based on industry insights and the intelligent use of technology. Key capabilities include data utilization, the development of CRM programs and the creation of e-commerce platforms, while the services provided to its clients cover the whole range from strategic planning to the implementation and management of solutions. Magnetix's clients include major companies in Denmark as well as multinational blue-chip corporations from a variety of industries. Rated Denmark's number one digital agency for brand position and brand strength in 2014 and 2015, the digital and direct marketing solutions it provides are highly regarded by its clients.
SAME SAME (France)	2015	SAME SAME is an advertising consulting agency that has established a reputation for its creative production and consulting services, including the formulation of advertising strategies and the digital domain. Headquartered in Paris, the agency provides services to client companies who are developing global luxury and premium brands. SAME SAME's 150 employees work in offices in Paris, New York, Shanghai and Hong Kong.
Lesmobilizers (France)	2014	Lesmobilizers designs mobile experiences as well as comprehensive digital strategies centered on mobile technology. The company also has strong expertise in video streaming as well as in mobile commerce, and has experienced rapid growth. Lesmobilizers has been integrated as a new department within the Dentsu Group's full-service digital creative agency Isobar France, leading further development in the mobile business sector and enhancing the range of services provided.
Markenloft (Germany)	2017	Markenloft provides activation services to connect businesses with consumers, including the planning and management of various events designed to enable consumers to experience a brand's

		products and services as well as the sponsorship of sports competitions. In addition to the implementation and management of events, these services include consulting and the development of communication strategies to leverage the client company's brand activation activities.
explido (Germany)	2014	explido is a leading performance and search agency in Germany. With offices in Augsburg, Hamburg and Frankfurt, explido provides a full range of outstanding capabilities in search marketing, affiliate marketing, display advertising, web development and conversion optimization as well as social media services.
Simple Agency (Italy)	2013	Simple Agency is a digital marketing services provider which leverages the potential of digital advertising through a multichannel management model based on display, automated buying, video advertising, performance media, search, mobile and social. Established in 2008, Simple Agency has built a fast-growing business, with a highly-skilled team, providing services to multinational and local companies.
Oxyma (Netherlands)	2017	Oxyma, which comprises a group of five specialist agencies, is the leading omni-channel agency in the Netherlands. With over 300 professionals in CRM, data, technology, and performance marketing, the agency now offers a full suite of services in digital marketing, digital media, mobile and SMS, and CRM consulting across all media channels. In 2017 Oxyma was listed in five categories as a "best performer" in Emerce 100, a special annual edition of the Dutch e-business/marketing industry magazine Emerce. The agency was recognized in the categories of Analytics, Digital Marketing, E-mail Marketing and Mobile and Social Content.
Divisadero (Spain)	2017	DIVISADERO is a data-driven and analytics consultancy business specializing in digital intelligence and digital transformation with

		strengths that enable a strategic and tactical approach to transforming data into information, and information into decision making. The company offers a number of data and analytic capabilities, including digital maturity assessments, strategic road mapping, technology benchmarking, data collection, analytics and data activation. At present, DIVISADERO employs over 90 people, most of whom are engineers and data analysts.
Alesport (Spain)	2016	Alesport Group is a leader in the sports and event marketing industry. The four companies under the Alesport umbrella are RMP Racing, which plans and organizes sports events such as two-wheel and four-wheel motor sports, cycling, car racing, mountain bike racing and marathons; RPM Events, which plans and operates B-to-B events; Alesport, a specialized sports publishing company; and Aventurismo, which is responsible for making travel and accommodation arrangements related to competitions and other events. As one of the major specialist sports marketing groups in Spain, Alesport is involved in the planning and operation of third-party events as well as its own sports events.
Outfox Intelligence (Sweden)	2017	Outfox is an advertising agency that consists of 14 top class consultants, including its two founders. In addition to being authorized as a Google Analytics Certified partner and a leading sales and service partner for Google Analytics 360 Suite1, Outfox is also a certified partner of Optimizely, earning a strong reputation as the largest corporate authorized reseller in the Nordic region (Sweden, Denmark, Finland, Norway and Iceland).
Aquila Insight (UK)	2017	Aquila Insight is one of the largest independent data analytics companies in the UK, with headquarters in Edinburgh and London. The company, comprised of over 60 statisticians and data scientists, offers predictive analytics, media mix optimization, digital analytics and CRM to top brands throughout Europe, helping them develop data-driven strategies to drive ROI.

The Customer Framework (UK)	2017	Customer Framework is a consultancy headquartered in London. Amid the increasing importance of digital transformation and data usage, the company draws on its strength of knowledge and expertise in this area to support corporations in dialogue and engagement with consumers and restructuring the management of those processes.

In addition to its investment in or alliance with EU martech firms, Dentsu has also invested in a variety of martech ventures in other countries as well, as shown in the table below.

Table 6.4 Dentsu's alliance with martech ventures in countries other than the EU countries

HelloWorld (US)	2018	HelloWorld is a provider of advertising consulting services throughout the entire digital marketing domain, focusing on promotion and loyalty marketing solutions. Over the years HelloWorld has earned high acclaim by offering outstanding services to major client companies across such industries as beverages, cosmetics, toiletries, information and communication. Today the company comprises approximately 370 professionals, and has expanded to offices in Seattle, Chicago, New York and Los Angeles.
DWA (USA)	2017	DWA is an award winning digital agency with proven results for some of the world's most successful and innovative technology companies. The agency is comprised of over 150 skilled experts in integrated technology, creativity, communication strategy, personal development, web optimization and demand generation. Headquartered in San Francisco, DWA has offices in Singapore, Bangalore, Beijing, London and Munich.
Swirl (US)	2017	Swirl is a full-service digital marketing agency focused primarily on digital advertising and social media marketing services. Today it has grown to an agency with over 175 employees delivering services in strategy, creative, media planning and execution, and content production centering on social media. With additional strengths in branded content and eCRM, Swirl is positioned as the largest independent agency in San Francisco, with the San Francisco Business Times, and SF Weekly giving it their highest rankings.

Covario (US)	2014	Cavorio was selected by OMMA magazine as the Search Agency of the Year a record three years in a row from 2011 to 2013. It was also ranked in 2013 by Advertising Age magazine among the nation's Top 10 search agencies. Headquartered in San Diego, the firm also has team members located in Beijing, Chicago, London, New York, Phoenix, San Francisco, Sao Paulo, Seattle, Singapore, Tokyo, Toronto, and elsewhere around the world.
Navegg (Brazil)	2016	Navegg manages and operates data management platforms which provide online audience data. The company's greatest strength is its strong relationships with publishers and websites that enable it to store and analyze more than 10 billion audience data events every month. Partnering with more than 100,000 sites, including blogs, portal, price comparison and e-commerce sites, Navegg is one of the largest DMP providers in Brazil, and supports the marketing activities of publishers and enterprises. The company also provides data-strategy consulting services that analyze and utilize this data in the customer relationship management (CRM) domain. Navegg's clients include Brazil's leading online publishers as well as platform companies that utilize performance-based advertising across North and Latin America.
Darwin (China)	2016	Darwin is one of the leading digital advertising consultancies in China. The company's strengths include search engine marketing (SEM) and other digital advertising services in the performance domain as well as word-of-mouth advertising using social media. Darwin's advanced services have earned it a high reputation not only among local companies but also a large number of global companies.
Sokrati (India)	2017	Sokrati is India's leading data-driven performance marketing and analytics agency. With an experienced team of 138 talented individuals, Sokrati offers integrated digital services centered on advanced data analytics and CMR based marketing, including the integration of offline and hyperlocal marketing, to its predominately e-commerce client base.
Valuklik (Indonesia)	2017	Valuklik, with an experienced team of 55 individuals, delivers digital marketing services across all digital media channels, including SEM, SEO, social media, programmatic media and performance content, and has grown to become one of Indonesia's leading digital performance companies. Valuklik is a Premier

		Google Partner and maintains strong partnerships with a number of internet business platform providers both inside and outside Indonesia, collectively placing the company in high regard equally among its clients and peers.
Little Giant (New Zealand)	2017	Little Giant is one of New Zealand's leading digital agencies providing digitally focused creative services from Auckland's Central Business District. The agency partners with clients to create and implement digital products and services, brand communications and experiences, and cross-channel, digitally-led campaigns.
People & Screens (Russia)	2017	People & Screens comprise 27 specialists in sales, account management, media planning, mobile trading, data analytics and back office functions. The newly launched agency aims to become a full-service agency for "app economy" clients whose key form of communication with customers is mobile apps and whose customer is a mobile consumer.
Novus Group Holdings (Singapore)	2017	Novus is a multiplatform content and brand-publishing agency offering a full spectrum of services in the content marketing domain, from strategy through to content creation and management. The agency, with a staff of 35 that largely comprises teams in editorial, design and digital, has grown to become one of the largest independent content marketing companies in South East Asia, delivering content solutions with digital capabilities to both local and multinational corporations in Singapore and across the region.
FoxP2 (South Africa)	2017	FoxP2 is a comprehensive creative agency that integrates strategy, design, digital and creative advertising into innovative results for its clients. Through its branches in Johannesburg and Cape Town, it has grown into a company with 83 expert employees. According to the UK's "The Gunn Report" 2016 ranking of winners of major advertisement awards, FoxP2 took 2nd place among the list of South African winners. In addition, the agency has garnered a number of prestigious international advertising awards including at this year's UK D&AD Awards and at One Show in the US.

Like Dentsu, Hakuhodo has also been active in partnering with martech ventures in major advertising territories to compete against Dentsu. The table blow shows an example of Hakuhodo’s investment in a martech venture in Canada.

Table 6.5 Example of martech venture that Hakuhodo has invested in		
Sid Lee International (Canada)	2015	Sid Lee is a global creative company with offices in six cities in Canada, the Netherlands, France and the US that transforms brand experiences across a wide range of disciplines, including advertising, architecture, digital marketing, social marketing, interior design, content, branding, customer relationship marketing and data analysis, and events and store activation. Sid Lee is highly regarded inside and outside the advertising industry. Its entries into award shows have garnered over 300 prizes at top-tier competitions including the International Festival of Creativity at Cannes, D&AD, One Show and Marketing Awards. In 2014, it was named independent agency of the year by France's Grand prix des agences de l'annee and agency of the year by the influential Canadian marketing journal Marketing Magazine (four times since 2009). The agency, which has around 550 professionals with an array of specializations from over 27 countries, is partner to numerous global companies.

6.4 Knowledge transfer opportunities in the area of AI for advertising services

One of the martech areas that have captures attention in Japan is martech using AI (artificial intelligence). A growing number of pilot projects for the development of AI-based martech has taken place in Japan.

Corporate alliances for the development of AI-based martech tools

For example, in 2018, Dentsu created an internal team named AI Mirai, which consists of about 40 experts in the AI technology field.[287] Those experts previously engaged in the development of AI-based martech tools, including the AI-based TV ratings prediction tool called "SHAREST" and the AI-based copyrighting tool called "AICO." The new team will develop the AI-based marketing tool called "AI MIRAI Marketing," among others.[288]

[287] The press release as of 16th January 2018 published by Dentsu (Japanese): https://dentsu-ho.com/articles/5760.

[288] The website of Dentsu regarding AI Mirai Marketing (Japanese): http://www.dentsu.co.jp/business/digital_marketing/ai_mirai/.

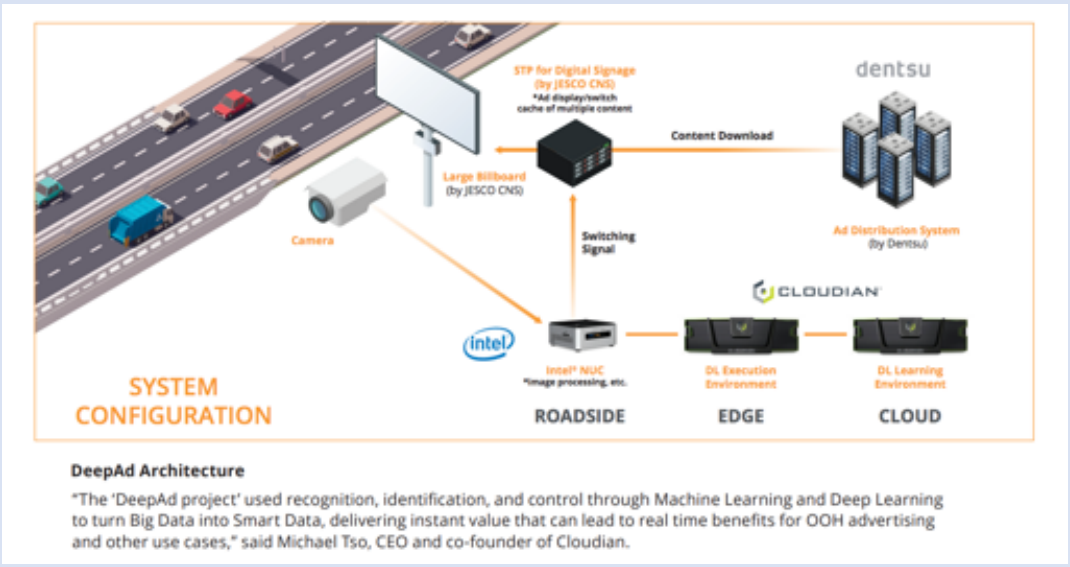
In collaboration with cutting-edge IT companies in Japan and the US, Dentsu has promoted the project called "DeepAd Project" since 2016.

Table 6.6 DeepAd Project

Project members: Dentsu (Japan), Cloudian (US), Intel (US), Smart Insight (Japan), Quanta Cloud Technology (Japan), Jesco CNS (Japan)

Description of the project:

The purpose of DeepAd Project is to create a targeted outdoor advertising system based on the combination of AI, big data and Internet of Things (IoT) technologies. The first step in the project is to set up a digital sign board specifically tailored for drivers near a major highway in Tokyo. By using video feeds from street cameras, computers automatically analyze passing automobiles to gather clues on the brands and types of the cars so that Dentsu can display pre-programmed ads to the drivers. This technology will be used to promote other products in the future by using AI and big data technologies to analyze what drivers want, based on the types and brands of cars they are driving, for example, promoting coffee to long-distance truck drivers to urge them to take a break. After this experiment, Dentsu plans to run the targeted ads at places such as shopping malls and tourist spots.



DeepAd Architecture

"The 'DeepAd project' used recognition, identification, and control through Machine Learning and Deep Learning to turn Big Data into Smart Data, delivering instant value that can lead to real time benefits for OOH advertising and other use cases," said Michael Tso, CEO and co-founder of Cloudian.

Source: The project brochure published by Intel.[289]

[289] Available at: https://storagebuilders.intel.com/docs/Deep-Learning-Enables-Intelligent-Billboard.PDF.

Information Services International-Dentsu, Ltd. (ISID), a major subsidiary of Dentsu, has also recently been very active in developing AI-based marketing technologies. In 2017, in collaboration with Sony Computer Science Laboratories (SCSL) and the Japanese AI venture Coozyt, a spin-off from SCSL, ISID started the development of the AI-based big data analytics system called "CALC."[290]

On the other hand, in 2017, Hakuhodo started collaborating with Preferred Networks, a rapidly growing Japanese AI venture to co-promote the application of AI technology in advertising mechanisms.[291] In the same year, Hakuhodo also made a partnership agreement with the US-based AI venture DataRobot with the aim of utilizing DataRobot's AI technology as the marketing intelligence component of the Hakuhodo DY Group.[292]

SoftBank, a Japanese IT giant investing in a wide area of AI ventures around the world, has also been keen on AI-based martech. In 2017, SoftBank invested, together with other companies including Line, in the Taiwanese startup Appier that provides corporate clients with AI-based services to analyze and have deeper insight into their users and also better understand forecasts of user behavior.[293]

Industry-academia collaboration for the development of AI-based martech tools

AI researchers at academic organizations have also engaged in collaborative research with large advertising agents to co-develop state-of-the art martech tools. For example, the online advertising giant CyberAgent has created an in-house AI laboratory called AI Lab,[294] and the lab is now developing AI-based tools for online advertising or consumer services in collaboration with the research centers mentioned in the table below.

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[290] The press release as of 30th May 2017 published by ISID (Japanese): https://www.isid.co.jp/news/relase/2017/0530.html.

[291] The press release as of 11th December 2017 published by Hakuhodo (Japanese): http://www.hakuhodo.co.jp/archives/announcement/43572.

[292] The press release as of 17th October 2017 published by Hakuhodo Global: https://www.hakuhodo-global.com/news/hakuhodo-dy-holdings-adopts-datarobots-ai-platform.html.

[293] The announcement on the website of Appier (Japanese): https://www.appier.com/jp/corporate.html.

[294] The website of AI Lab of CyberAgent: https://www.cyberagent.co.jp/techinfo/labo/ai/.

Table 6.7 CyberAgent's partnership with universities in the AI field

- Osaka University
  - Intelligent Robotics Laboratory: http://www.irl.sys.es.osaka-u.ac.jp/
- Tokyo Institute of Technology
  - Okumura-Takamura Laboratory (Natural Language Processing Group): http://lr-www.pi.titech.ac.jp/wp/
- The University of Tokyo
  - Sugiyama-Sato-Honda Laboratory (Department of Complexity Science and Engineering): http://www.ms.k.u-tokyo.ac.jp/index.html
- Yale University
  - Dr. Yusuke Narita, Assistant Professor of Economics: https://economics.yale.edu/people/yusuke-narita
- Riken
  - Dr. Takanori Maehara, Discrete Optimization Unit, Center for Advanced Intelligence Project: http://www.riken.jp/research/labs/aip/generic_tech/discr_optimize/

Dr. Kano, Associate Professor at Shizuoka University, an expert in AI for natural language processing, has collaborated with Dentsu to produce the above-mentioned AI-based copyrighting tool called "AICO."[295]

[295] The website of Kano Lab at Shizuoka University: http://kanolab.net/index.ja.php.

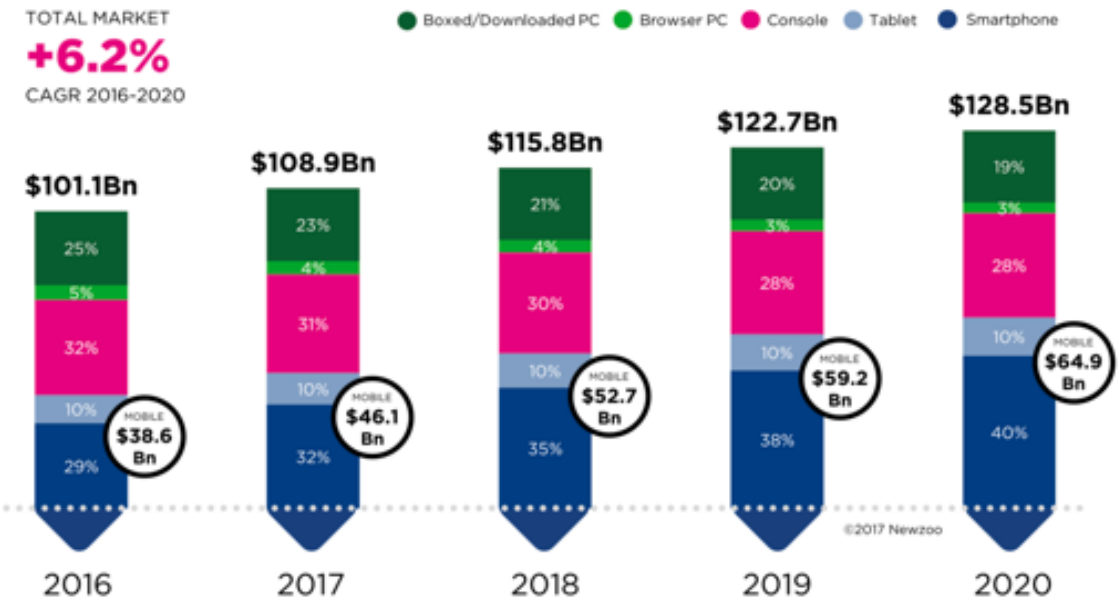
7. Game

7.1 The booming games market in the world and in Japan

The global games market

The global games market is rapidly expanding. According to an estimate published by Newzoo,[296] 2.2 billion gamers across the globe are expected to generate USD 108.9 billion in game revenues in 2017.[297] This number shows an increase of USD 7.8 billion, or 7.8%, from the year before. Digital game revenues will account for USD 94.4 billion or 87% of the global market. Mobile gaming is the largest segment, with smartphone and tablet gaming growing 19% year over year to USD 46.1 billion, accounting for 42% of the market. In 2020, mobile gaming is expected to represent more than half of the total games market.

Figure 7.1 2016-2020 Global Games Market



Source: Newzoo, *2017, 2016-2020 Global Games Market*.[298]

[296] The website of Newzoo: https://newzoo.com/about/.

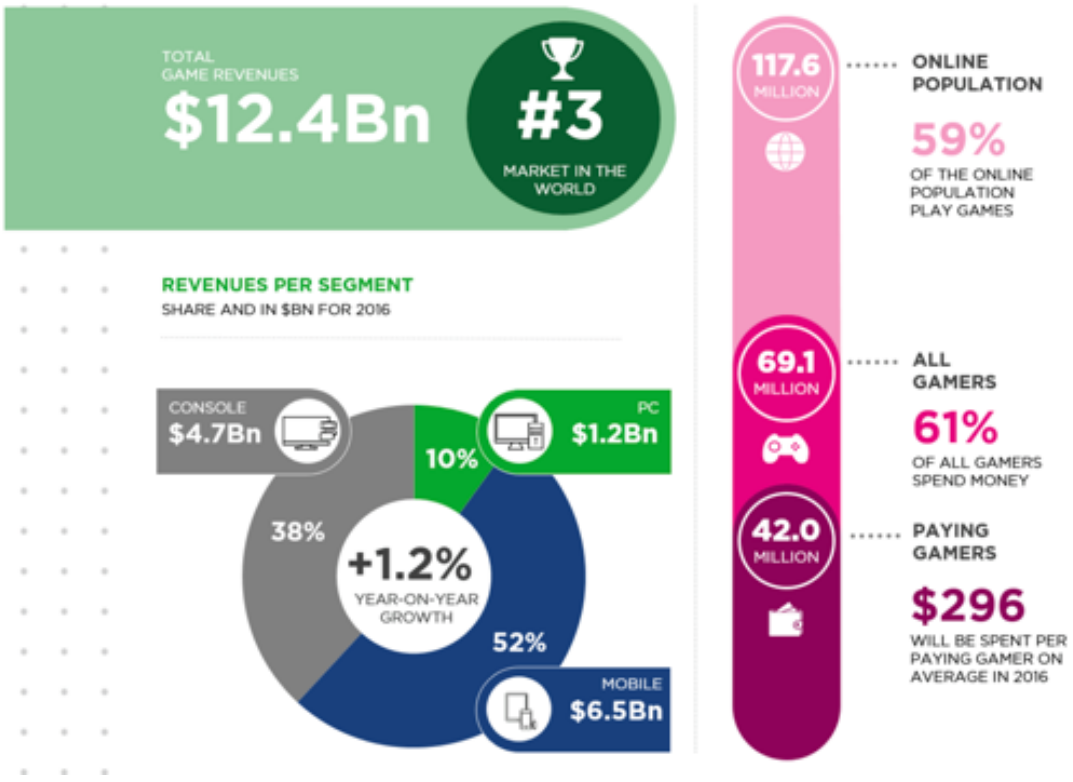
[297] Newzoo, 2017, *2016-2020 Global Games Market*. Available at: https://newzoo.com/insights/articles/the-global-games-market-will-reach-108-9-billion-in-2017-with-mobile-taking-42/.

[298] Ibid.

The Japanese games market

In line with the growth of the global games market, the Japanese games market is also expanding. According to an estimated published by Newzoo, in 2016, the Japanese games market is worth USD 12.4 billion, and the 3rd largest games market in the world, after China and the US.[299] There are 69 million gamers in Japan and 61% of them spends money. Mobile gaming is the largest segment with the revenues of USD 6.5 billion.

Figure 7.2 The Japanese Game Market – Key 2016 Facts



Source: Newzoo, 2016, *The Japanese Games Market 2016*.[300]

7.2 The Cool Japan initiative and Tokyo Game Show

The Cool Japan initiative

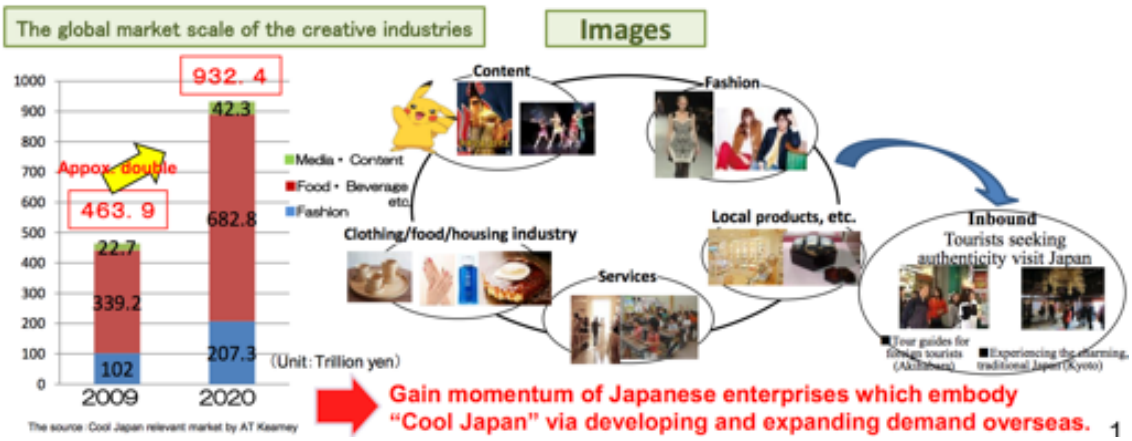
The Japanese government has regarded the creative industries, including the game industry, the fashion industry, the food industry, the music industry, as one of the important policy targets

[299] Available at: https://newzoo.com/insights/infographics/japanese-games-market-2016/.

[300] Ibid.

within the context of its Cool Japan initiative. The Cool Japan initiative is based on the idea that to promote the overseas expansion of the Japanese creative industries can lead not only to boosting the revenues in the industries but also to creating positive images of Japanese culture around the world, which may also result in some desirable benefits to Japan, such as boosting the inbound flow of foreign tourist into Japan and upgrading so-called "soft power" of Japan.[301] For this reason, the Japanese government has intensified its effort to promote the expansion of the Japanese creative industries into the global market.

Figure 7.3 The conceptual diagram of the Cool Japan initiative of the Japanese government



Source: METI, 2014, *Cool Japan Initiative*.[302]

As part of the Cool Japan initiative, for example, METI has promoted Tokyo Game Show (see below). METI has also supported the localization and promotion of Japanese media contents (e.g. games, films and TV programs) in foreign markets within the subsidy scheme called J-LOP.[303] METI has actively taken initiative in combatting against piracy especially in the Asian region through the activities of its agency called CODA (Content Overseas Distribution Association).[304] In terms of promoting the entrance of Japanese films into the global film

[301] In today's international relations, soft power is increasingly important. It can enhance a country's influence and indirectly its economic and political power. Culture in all its manifestations, history, tradition and social mores form its basis. Upgrading Japan's soft power in international relations is a vital element of the public diplomacy of the Japanese government. The website of the Ministry of Foreign Affairs of the Japanese government (Japanese): http://www.mofa.go.jp/mofaj/comment/faq/culture/gaiko.html.

[302] Available at: http://www.meti.go.jp/policy/mono_info_service/mono/creative/file/1406CoolJapanInitiative.pdf.

[303] The website of J-LOP: https://j-lop4.jp/english.

[304] The website of CODA: http://www.coda-cj.jp/.

market, UNI Japan, the industry-government-partnership-based organization that organizes the Tokyo International Film Festival every year, has engaged, under the sponsorship of the Agency for Cultural Affairs of the Japanese government, in the international co-production of films between film makers in Japan and other countries, including European countries.[305] Promoting the export of Japanese foods, including Japanese sake and wine, into the global market is also a vital part of the Cool Japan initiative.

Tokyo Game Show

The game industry momentum in Japan can be seen in Tokyo Game Show. Tokyo Game Show, which is held in September every year, is one of the world's largest international game trade shows. The major organizer of Tokyo Game Show is Computer Entertainment Supplier's Association (CESA), which is supported by METI. Tokyo Game Show is held as part of the large government-sponsored event called Japan International Contents Festival (CoFesta). CoFesta consists of four events: Tokyo Game Show, Tokyo Content Showcase (TIFFCOM, Tokyo International Music Market, and Tokyo International Anime Festival),[306] Tokyo International Film Festival,[307] and Anime Japan.[308]

In the Tokyo Game Show 2017, 609 game companies from 36 countries as well as more than 250,000 fans from all over the world participated.[309] With the goal of bringing foreign and Japanese game companies altogether in Tokyo Game Show, prominent publishers from around the globe are invited to join Tokyo Game Show, and many meetings between those publishers and game developers are organized.

As part of the Cool Japan initiative, METI and the CoFesta Executive Committee appoint "CoFesta Ambassadors" every year. The appointed ambassadors are to acquire a profound understanding of Japanese culture and contents, and to appeal its attraction to their country and

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[305] The website of UNI Japan: https://www.unijapan.org/english/.

[306] The website of Tokyo Content Showcase: http://www.jcs.tokyo/en/.

[307] The website of Tokyo International Film Festival: http://2017.tiff-jp.net/ja/.

[308] The website of Anime Japan: http://www.anime-japan.jp/en/.

[309] The Report of Tokyo Game Show 2017 published by Computer Entertainment Supplier's Association (CESA). Available at: http://expo.nikkeibp.co.jp/tgs/2018/exhibition/common/pdf/01_2017_result.pdf. In terms of attracting foreign game developers, Tokyo Game Show has been in a rivalry relationship with Korea's game show G-STAR. The website of G-STAR: http://www.gstar.or.kr/.

the world. CoFesta Ambassadors take part in a variety of government-sponsored events including Tokyo Game Show.[310]

7.3 Possible areas for knowledge transfer with Japanese counterparts in the game business field

Under the game industry momentum, an increasing number of Japanese game companies have actively invested in or partnered with foreign game companies, including game companies in the EU. The table below indicates examples of possible areas for knowledge transfer with Japanese counterparts in the game business field.

Table 7.1 Possible areas for knowledge transfer with Japanese counterparts in the game business field
• Knowledge transfer opportunities in the area of virtual reality (VR) technology for games
• International co-production of games for the global game market
• Knowledge transfer opportunities in the area of AI-based games
• Knowledge transfer opportunities in the area of supporting technology for games

7.4 Knowledge transfer opportunities in the area of virtual reality (VR) and augmented reality (AR) technology for games

Growing demand for virtual reality technology for game products

Virtual Reality (VR) can be defined as a fully immersive computer simulated environment that gives one the feeling of being in a virtual world, instead of their actual world. VR is a super-realistic reality that replicates sensory experiences like sight, touch, hearing and smell.
VR is the current frontier in gaming, although, technically speaking, VR is not new technology. There have been recognizable VR gaming efforts since the 1990s. After 30 years of technological developments, the VR boom is finally a reality, thanks to an influx of large sums of investment in hardware from top technology companies since 2016.

[310] The website of CoFesta Ambassadors: https://www.cofesta.go.jp/ambassador/news/2017-cofesta-ambassador-recruitment-information.

At the same time, technology for augmented reality (AR) is also receiving an increasing amount of attention. AR is a direct or indirect live view of a physical, real-world environment whose elements are "augmented" by computer-generated perceptual information. With the assistance of advanced AR technologies, basically consisting of technologies for computer vision and object recognition, the information about the surrounding real world of the user becomes interactive and offer perceptually enriched experiences. An example of the use of AR technology into games is Pockemon Go.[311]

In line with the global VR/AR momentum, an increasing number of technology giants have invested in VR/AR technologies, as shown in the table below that indicates examples of such investments in 2016.

Table 7.2 Examples of involvement in VR/AR by technology giants in 2016

Company	Date	Details
Qualcomm	Jan-12	Raised seed funding for the mobile augmented reality startup Blippar
Google	Apr-12	Introduced augmented reality glasses, Google Glass, to the public
Sony	Mar-14	Sony announces Project Morpheus, later renamed PlayStation VR
HP	Mar-14	Launched Aurasma 3.0, an augmented reality platform that it acquired through Autonomy
Facebook	Mar-14	Acquired Oculus, a virtual reality startup, for $2bn
Samsung	Sep-14	Revealed its own head-mounted display, Samsung Gear VR, partnering with Oculus
Google	Oct-14	Invested $542mn in the startup Magic Leap
Intel	Apr-15	Invested in Series A funding for the virtual reality startup WorldViz
Apple	May-15	Reportedly acquired Metaio, an augmented reality software maker
Disney	Sep-15	Led a $65mn funding round in Jaunt, a VR content startup
Microsoft	Oct-15	Acquired Havok, a 3D physics engine used for videogames
Comcast & Time Warner	Nov-15	Participated in a $30.5mn funding round for NextVR, which captures live events in VR
Apple	Nov-15	Acquired Faceshift, a facial recognition capture and animation company
Fox	Jan-16	Acquired minority stake in Osterhout Design Group, a VR/AR HMD maker

Source: Goldman Sachs, 2016, *Equity Research: Profiles in Innovation – Virtual and Augmented Reality*.[312]

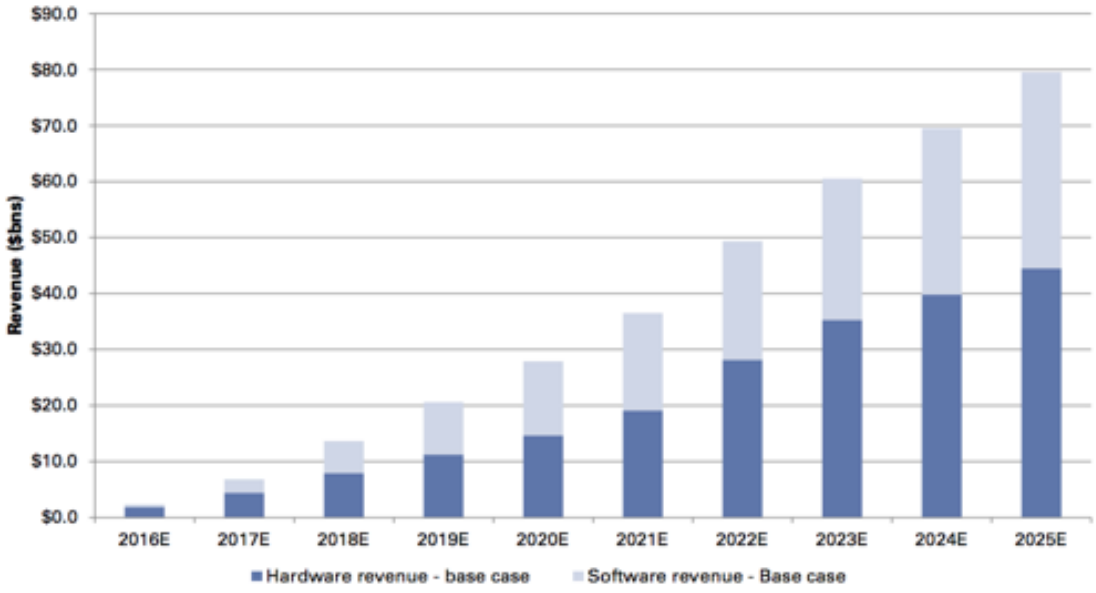
According to Goldman Sachs Asset Management, the VR/AR market for a diverse area of services and products including games is expected to grow to approximately USD 80 billion (USD 45 billion in hardware, USD 35 billion in software) by 2025, and there are predictions

[311] The website of Pockemon Go: https://www.pokemongo.com/.

[312] Available at: http://www.goldmansachs.com/our-thinking/pages/technology-driving-innovation-folder/virtual-and-augmented-reality/report.pdf.

that the VR/AR market could grow to become the third platform following PCs and smartphones.[313]

Figure 7.4 The estimated progression of the VR/AR market



Source: Goldman Sachs, 2016, *Equity Research: Profiles in Innovation – Virtual and Augmented Reality*.[314]

In line with the global VR/AR momentum, major Japanese game developers are also very active in investing in or partnering with VR ventures around the world. There are many chances for VR/AR ventures in the EU to conduct knowledge transfer with Japanese game companies. The following are examples of Japanese game companies that EU VR/AR ventures may partner with in this respect.

Knowledge transfer opportunities with Gumi

Gumi is a leading global mobile game publisher and developer headquartered in Japan, with overseas operations in France, Korea, Singapore, Taiwan and the United States. Gumi took the number one spot in the 10th Deloitte Technology Fast 50 Japan in 2012 in recognition of the company's tremendous expansion. Gumi has actively invested in or partnered with foreign

[313] Ibid.

[314] Ibid.

VR/AR companies, including EU entities in the VR/AR field. The table below shows three examples of Gumi's international corporate alliances in this regard.

Table 7.3 Examples of Gumi's international corporate alliances	
inXile (USA)	In 2017, Gumi VR, a venture capital arm of Gumi, invested USD 4.5 million in a US-based VR venture inXile Entertainment.[315]
Nordisk Film for Nordic VR Startups (Denmark)	In 2017, Gumi created an incubator program named Nordic VR Startups (NVS) in Helsinki, in collaboration with Nordisk Film, a leading producer and distributor of films in the Nordic countries as well as a leading developer of computer games, to create and promote an incubator program named Nordic VR Startups (NVS) targeting at Nordic VR/AR ventures.[316] The aim of Nordic VR Startups is to find promising startups specialized in VR/AR, and offer them financing and support in reaching the global market. The program provides workspaces and back-office services, as well as expert guidance and support for both development and business. Participating studios will also receive up to EUR 100,000 in dedicated seed funding to create VR/AR prototypes. In the program, the selected Nordic VR/AR startups participate in events such as the startup event Arctic 15 and X Reality Day, presenting their projects to the program stakeholders, partners and Nordic VR/AR developers.
EUVR (Belgium)	Gumi has partnered with EUVR, a non-profit organization that works to help connect European VR/AR developers with potential investors and partners and provide additional resources to help them develop their games.[317] Through this partnership, Gumi promotes its collaborative relationship with innovative VR/AR ventures in the EU, while VR/AR

[315] The press release as of 12th July 2017 published by inXile: https://venturebeat.com/2017/07/12/inxile-gets-4-5-million-investment-from-gumi-for-an-open-world-survival-rpg-vr-game/.

[316] The press release as of 8th May 2017 published by Nordisk Film: http://www.nordiskfilm.com/int/Press/News/New-VRAR-Incubator-by-Nordisk-Film-and-Japanese-game-company-Gumi-Inc-is-coming-along-fast--Nordic-VR-developers-are-called-upon-to-apply/#.Wp97EJPFIgo.

[317] The website of EUVR: http://www.euvr.org/.

	ventures belonging to EUVR will be given better access to investment opportunities and incubation programs provided by Gumi.[318]

Knowledge transfer opportunities with Colopl

In January 2017, Colopl and Colopl Next, Colopl's wholly owned subsidiary engaging in the investment business, established Colopl VR Fund 2 with the capital of US$50 million to invest in VR companies all over the world.[319] Before the creation of this fund, Colopl and Colopl Next created the first VR fund in 2016, which has invested in over 30 VR technology companies all over the world, which include the companies shown in the table below.

Table 7.4 Colopl VR Fund investments

Source: The website of Colopl Next.[320]

[318] The press release as of 17th January 2017 published by Gumi (Japanese): https://gu3.co.jp/news/archives/8655/.

[319] The press release as of 31st January 2017 published by Colopl (Japanese): http://colopl.co.jp/news/pressrelease/2017013101.php.

[320] Available at: https://www.coloplnext.co.jp/vr. Also see the press release as of 31st January 2017 published by Colopl: http://v4.eir-parts.net/v4Contents/View.aspx?template=announcement&sid=34478&code=3668.

Knowledge transfer opportunities with SoftBank

SoftBank is also keen to invest in VR/AR technology. Examples of SoftBank's investment in VR/AR technology includes its investment in Improbable in the UK, as shown in the table below.

Table 7.5 Example of SoftBank's investment in VR/AR technology	
Improbable (UK)	In 2017, Improbable, a London-based VR/AR technology startup, raised USD 502 million in a round of Series B funding led by SoftBank.[321] Improbable made its name with its platform called SpatialOS. Launched last year, the platform lets developers design and build massively detailed environments by using distributed cloud computing infrastructure, incorporating machine learning technology and other advances. Improbable is also applying the same technology that powers SpatialOS to the simulation of complex real-world systems. Potential applications include simulating transport infrastructure, telecommunications networks or the behavior of fleets of autonomous vehicles. All the funds from the investment will be invested in developing Improbable's technology, including its SpatialOS distributed operating system. Alongside the investment, Improbable will explore and identify opportunities for mutually beneficial relationships with SoftBank, its partners and portfolio companies.

Knowledge transfer opportunities with Sony

Sony is also keen on developing VR/AR technologies such as Playstation VR and AR device SmartEyglass. In line with this product development strategy, Sony acquired SoftKinetic in Belgium in 2015.

Table 7.6 Example of Sony's investment in foreign VR ventures	
SoftKinetic (Belgium)	In 2015, Sony acquired the Belgium-based IT company SoftKinetic.[322] SoftKinetic provides 3D vision and gesture recognition technology to the interactive digital entertainment such as serious games, consumer

[321] The press release as of 12th May 2017 published by Improbable: https://improbable.io/company/news/2017/05/11/improbable-raises-502m-series-b-funding-round-led-by-softbank.

[322] The press release as of 8th October 2015 published by Sony: https://www.sony.co.jp/SonyInfo/News/Press/201510/15-083/index.html.

	electronics, health & fitness. SoftKinetic's technologies support interactions between the wearer of AR devices or VR headsets and real-world objects, by, for instance, enabling the headset to know when the wearer is approaching or handling real-world objects. SoftKinetic's sensing technology is expected to be integrated into diverse solutions, such as automated driving systems.

Knowledge transfer opportunities with GREE

In 2016, with the aim of investing in early-stage VR/AR ventures around the world, GREE, a Japan-based global leader in the mobile game industry, created the USD 50 million GFR Fund in the US.[323] GFR Fund highlights GREE's commitment to the potential of VR/AR as an emerging game technology field. Prior to the creation of this fund, GREE created GREE VR Studio in 2015 and published its first VR game title that was presented at the Tokyo Game Show in 2015.

7.5 International co-production of games for the global game market

There are cases where a Japanese game developer invests in or partners with a EU game developer with the aim of co-producing high-quality game contents, based on the competitive game development capacity of the EU game developer, for the global game market. The table below shows three examples of corporate alliances between Japanese and European game developers in this regard.

Table 7.7 Examples of alliances between Japanese and European game developers for co-production of games

Amplitude Studios (France)/ Sega (Japan)	In 2016, as part of its global marketing strategy, Sega Games acquired Amplitude Studios, a Paris-based venture which works on the turn-based science fiction game series, Endless Space.[324] With the purchase of Amplitude Studios, Sega Games aims to increase its presence in the global market for both PC and turn-based games, continuing its recent trend.

[323] The website of GFR Fund: https://www.gfrfund.com/.

[324] The press release as of 5th July 2016 published by Sega Sammy: https://www.segasammy.co.jp/english/pdf/release/20160705_amplitude%20studios_e.pdf.

Gameloft (France)/ GungHo (Japan)	In 2016, GungHo Online Entertainment in Japan, and Gameloft in France, two leading digital and social game developers, reached a non-binding framework agreement to cooperate in the creation and distribution of high quality mobile games in the global mobile game markets.[325] The first stage of this strategic alliance kicks off with Gameloft's upcoming mobile gaming title *Disney Magic Kingdoms* for which GungHo has been granted by Gameloft the exclusive distribution right in Japan. GungHo has worked closely with Gameloft's development team in Toronto to create a version that will reach the renowned high expectations of Japanese players.
Ankama Games (France)/ Gumi (Japan)	In 2014, Gumi and Ankama Games, a France-based fast-growing game developer, entered into a strategic partnership focused on mobile gaming to put together their strength in development and distribution of mobile games in the global mobile game market.[326] The company opened its subsidiary in Paris few months before the agreement in order to be closer to its European partners.

7.6 Knowledge transfer opportunities in the area of AI-based games

In the field of the development of AI-based games, the Japanese AI venture Heroz has been a key player in the Japanese market. Founded in 2009 by two IT engineers from the Japanese electronics giant NEC, Heroz, which now has about 70 employees, develops and markets AI-based shogi and chess games for smartphones, which provide the source of data for development of its machine-learning systems. Heroz is the creator of the Shogi (Japanese chess) AI *Ponanza*, which made headline for beating professional players in public matches.[327]

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[325] The press release as of 1st December 2016 published by Gameloft: http://www.gameloft.com/corporate/press-room/press-details/?id=4194&ref=https%3A%2F%2Fwww.google.co.jp%2F.

[326] The press release as of 12th March 2014 published by Gumi (Japanese): https://gu3.co.jp/files/pdf/820a2ccb-5884-4b1a-9d0c-47415930892f/20140312_01.pdf.

[327] In 1997, the IBM-developed chess computer Deep Blue became the first computer to beat a top chess player. However, because the form of shogi (Japanese chess) is more complicated than the conventional form of chess, it took 16 additional years before a computer program was able to master the shogi game.

Heroz reached a partnership agreement with Bandai Namco Entertainment in 2016[328] and Koei Tecmo in 2017,[329] respectively, with the aim of combining Heroz's AI technologies into the two large Japanese game companies' game development capabilities for producing new AI-based games. Heroz is also now getting into the fintech business, while partnering with the online security trade company Manex for co-producing an AI-based robot advisor for investment.[330] (For the information on AI-based investment robo advisors, see Section 3.6 above.)

AI-based gaming is a possible technology area for EU AI entities' knowledge transfer with Japanese counterparts, especially large Japanese game developers, in terms of approaching the Japanese and global game markets.

7.7 Knowledge transfer opportunities in the area of supporting technology for game products

There are opportunities for European companies to conduct knowledge transfer with Japanese companies in the field of supporting technology for game products are also increasing. For example, two Swedish companies have been successful in partnering with Japanese companies in the area of audio technology and scan texture for game development, respectively, as shown in the table below.

Table 7.8 Examples of opportunities for European companies to have alliance with Japanese companies in the field of supporting technology for game products

Audio technology	Dirac Research (Sweden) / Pioneer (Japan)	In 2016, Pioneer reached an agreement with Dirac Research, a Swedish audio technology company, to distribute Dirac's technology in the Japanese audio market.[331] Specializing in

[328] The press release as of 26th December 2016 published by Heroz: https://heroz.co.jp/press-release/2016/12/26heroz/.

[329] The press release as of 31st July 2017 published by Heroz: https://heroz.co.jp/press-release/2017/07/31heroz/.

[330] *Nikkei Shimbun Newspaper*, the article as of 22nd January 2018. Available at: https://www.nikkei.com/article/DGXMZO25915980Z10C18A1X11000/.

[331] The press release as of 21st April 2016 published by Dirac Research: https://www.dirac.com/news/2016/4/19/dirac-announces-strategic-audio-technology-distribution-agreement-with-

		digital room correction, sound field control and sound optimization, Dirac Research has developed a range of world-leading solutions tailored for different audio systems, such as speaker and earphone optimization, soundstage widening for multiple speakers, sound quality optimization for portable devices and digital room correction for HiFi systems. Dirac's technology aims for games, computer speakers, TV speakers and so on. With regard to the quality of Dirac's technology, Mr. Osamu Takechi, Senior General Manager of Pioneer Industrial Solutions Division states: "Completely different from conventional virtual surround and/or equalization, the Dirac solutions are both theoretically and practically proven to fundamentally improve an audio systems' performance."[332]
Scan texture	Quixel (Sweden) / Silicon Studio (Japan)	In February 2017, Silicon Studio, a Japanese game developer, reached a business alliance agreement with Quixel, a Swedish venture and provider of large scale scan-based texture libraries.[333] Quixel utilizes their specialized scanner to create ever expanding scan-based texture library of a multitude of natural scenes, flowers, rocks, trees, etc., provide, and sell these textures and 3D models through various online services. Quixel's clients include leading film production companies, game companies, automobile manufacturers, and government-related organizations. Under the agreement, Silicon Studio has become the official representative and reseller of Quixel's leading library product "MEGASCANS", for the Japanese, Korean, and Thai regions, and through cooperation in this business alliance, aims to strengthen the value of both "MEGASCANS" and Silicon Studio products.

pioneer.

[332] Ibid.

[333] The press release as of 3rd February 2017 published by Silicon Studio: https://www.siliconstudio.co.jp/en/news/pressreleases/2017/en1702quixel-megascans/.

7.8 Partnership opportunities with Japanese universities in education and research on game development

There are Japanese universities that have engaged in R&D and educational activities regarding game development. The following are examples of Japanese universities in this respect.

Table 7.9 Japanese universities engaging in education and research on game development

- The University of Tokyo
  - The Graduate School of Interdisciplinary Information Studies: http://www.u-tokyo.ac.jp/en/academics/grad_interdisciplinary.html
- Tokyo Institute of Technology
  - Department of Computational Intelligence and Systems Science: http://www.dis.titech.ac.jp/en/index.html
- Tokyo University of Technology
  - The Department of Game: http://www.teu.ac.jp/english/index.html
  - Since 2012, Tokyo University of Technology and Uppsala University (the Department of Game Design at Gotland Campus) in Sweden have been in an agreement for educational exchange and research collaboration in the field of game design and production.[334]
- Kyushu University
  - School of Design: http://www.design.kyushu-u.ac.jp/kyushu-u/english/
  - Kyushu University School of Design is now in partnership with Aalto University in Finland in the area of game design and production.[335]
- Ritsumeikan University
  - Ritsumeikan Center for Game Studies: http://en.ritsumei.ac.jp/research/organizations/ritsumeikan-center-game-studies/
- Digital Hollywood University: http://www.dhw.ac.jp/

[334] The news article as of 11th February 2012 on the website of Tokyo University of Technology (Japanese): http://blog.media.teu.ac.jp/2012/02/post-051d.html.

[335] The news article in 2017 on the website of Kyushu University Design School (Japanese): http://www.kidnext.design.kyushu-u.ac.jp/projects/view/61.

The largest academic association in the field of games is Digital Games Research Association Japan (DiGRA Japan).[336] In addition to universities, there are more than 30 private vocational schools that provide educational courses on computer programing for game development.

7.9 Partnership opportunities with Japanese game industry associations

Promoting the partnership between game industry associations in the EU and Japan may lead to facilitating knowledge transfer from EU game ventures to Japanese counterparts. The table below is a list of major game industry associations in Japan.

Table 7.10 List of Japanese game industry associations

- Computer Entertainment Supplier's Association (CESA): https://www.cesa.or.jp/
  - CESA is the major organizer of Tokyo Game Show (see above).
- Japan Online Game Association: https://japanonlinegame.org/
- Japan Computer Game Association: http://jcga.org/

7.10 Knowledge transfer/sharing opportunities with Japanese local cities for the development of the game industry clusters

The international competitiveness of a game industry cluster can boost local economy. So, two local municipalities in Japan, namely Sendai City and Fukuoka City, are keen on promoting game industry clusters within their territories by networking with game clusters in foreign cities.

Partnership between Sendai City (Japan) and Oulu (Finland)

Sendai City in Japan has now been trying to boost its local game cluster in collaboration with Oulu City in Finland. In 2014, two entities in Oulu City, namely Oulu Game Lab (OGL) at Oulu University of Applied Sciences and Business Oulu, and three entities in Sendai City, namely Global Lab Sendai (GLS), the Sendai City Government and the Sendai Industrial Promotion

[336] The website of DiGRA Japan: http://digrajapan.org/?cat=38.

Organization, reached an agreement to mutually promote the development of the mobile gaming industries in Sendai and Oulu. One of the initiatives within this partnership is for OGL to conduct the transfer of knowledge and know-how in mobile game development with GLS so that GLS can learn how to effectively nurture the game cluster in Sendai.[337] On the other hand, GLS supports the localization of game products developed by OGL for the Japanese game market.

Fukuoka City as a growing international game industry cluster

Fukuoka City, the largest city in the Kyushu area of Japan, has successfully promoted the IT industry, including the game industry, to become a crucial pillar of its local economy. Fukuoka City now has over 2000 software and digital content companies. The number of ICT companies relocating to Fukuoka City is still increasing annually. For the period of six years from 2008 to 2014, a total of 114 ICT companies relocated to Fukuoka City. Those companies include the regional offices of major ICT companies such as Yahoo, LINE, and the social gaming giant Gumi. Furthermore, the rate of startup establishment in Fukuoka City was 6.2 percent of all companies in 2012, which arose to 7.1 % in 2013. The Fukuoka City Government plans to raise the figure to 13 % by 2018.

In March 2014, Fukuoka City was designated by the Cabinet Office as a National Strategic Zone for Job Creation. Based on this designation, the Fukuoka City Government has taken several initiatives to promote its local IT industry clusters, including the game industry cluster, under its vision of "Startup City Fukuoka." One initiative taken by the Fukuoka City Government in this regard is to expand its networks with business incubation hubs in foreign countries, as shown in the figure below.[338]

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[337] The website of the Sendai City Government (Japanese): http://www.city.sendai.jp/jigyosuishin/jigyosha/keyaku/oshirase/2014/oru.html.

[338] The website of Startup City Fukuoka run by the Fukuoka City government: http://startup.fukuoka.jp/.

Figure 7.4 Fukuoka City's global startup network

Source: The website of Fukuoka City Startup run by the Fukuoka City government

In this international outreach activities, the Fukuoka City Government has created networks with the following European starup incubation hubs:

Table 7.11 The global startup network of the Fukuoka City in the EU region
• Enterprise Estonia (Estonia): https://www.eas.ee/?lang=en
• Startup Estonia (Estonia): http://www.startupestonia.ee/
• Tehnopol (Estonia): https://www.tehnopol.ee/en/
• NewCo Helsinki (Finland): https://newcohelsinki.fi/fi/
• Bordeaux Technowest (France): https://technowest.com/

In addition, in collaboration with Tsutaya, a private company with expertise in running business incubation platforms, the Fukuoka City Government has run the business incubation hub called "Startup Café" in the canter of the city to provide one-stop business consultation services for Japanese and foreign venture firms.[339] The Fukuoka Game Industry Promotion Agency, an industry-government-academia scheme, has promoted the development of the game industry cluster within Fukuoka City since its establishment in 2006.[340]

[339] The website of Startup Café Fukuoka City: http://www.startupcafe.jp/.

[340] The website of Fukuoka Game Industry Promotion Agency (Japanese): http://fukuoka-game.com/.

Furthermore, in order to promote the inflow of competitive foreign entrepreneurs into Fukuoka City, in 2015, the Fukuoka City Government adopted the new visa scheme called the "Startup Visa."[341] In the conventional Japanese visa scheme, a foreign entrepreneur who wishes to set up an office in Japan has to satisfy a strict set of conditions (e.g. capital/investments exceeding JPY five million). However, under the new visa scheme in Fukuoka City, a foreign entrepreneur who wishes to do business in that city in the specified knowledge-intensive business fields, including game production, will be given six months "Business Manager" visa after the screening and confirmation from the Fukuoka City Government and the Immigration Bureau, without the need for fulfilling the above-mentioned prerequisites.

[341] The website of the Fukuoka City Government regarding the Startup Visa scheme: http://www.city.fukuoka.lg.jp/keizai/r-support/business/startupviza_english.html.

8. IT for Fashion Business

8.1 Knowledge transfer opportunities in the field of body measurement technology for online made-to-order clothing services

According to the report titled "Apparel Market in Japan: Key Research Findings 2017," which was published by Yano Keizai Research Institute, the size of the entire domestic apparel retail market in 2016 in Japan was JPY 9,220.2 billion, 98.5% of that of the previous year, while the fashion e-commerce is expanding in the country.[342] At the same time, Japanese customers' demand for made-to-order clothing is rapidly growing.

In line with the growth of fashion e-commerce and the rising demand for made-to-order clothing, a growing number of fashion companies have created online made-to-order stores for Japanese customers. Examples in this regard can be seen in newly created online made-to-order shirts stores for Japanese customers, such as the ones run by the Tokyo-based Japanese venture Fabric Tokyo[343] and the Silicon-Valley-based American venture Original Stich,[344] respectively.

The point in this business model is how to take accurate body measurements. For example, First Retailing, Japan's largest fashion company running the UNIQLO brand, currently offers made-to-measure shirts in Japan and the US, and is planning to expand that business in Southeast Asia and Europe. UNIQLO's online sales is currently valued at JPY 100 billion globally, and the global online sales driven by made-to-order clothing is expected to account for about 30 per cent of overall sales of First Retailing. Importantly, customers using UNIQLO's made-to-measure services at first have to go to a UNIQLO store to have their body measurement taken in-store by a shop clerk.

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[342] Yano Research Institute, *Apparel Market in Japan: Key Research Findings 2017*. Available at: http://www.yanoresearch.com/press/pdf/1754.pdf.

[343] The website of Fabric Tokyo: https://fabric-tokyo.com/pages/about.

[344] The website of Original Stich: https://shop.originalstitch.com/#.

In 2015, Rakuten, Japan's largest e-commerce company, acquired a 100% stake in the virtual fitting room technology venture Fits Me, which was established in Estonia.[345]

Table 8.1 Rakuten's partnership with Fits Me	
Fits Me (Estonia)	Fits Me was founded in Estonia in 2010 by the Estonian entrepreneurs, Heikki Haldre and Paul Pallin, with the technological cooperation from Maarja Kruusmaa, a professor of biorobotics at the Tallinn University of Technology, the laboratory of intelligent materials and systems at the University of Tartu, and Europe's largest body scanning and anthropometry research company, Human Solutions GmbH in Germany.[346] Fits.me was financially backed by institutional investors Conor Venture Partners, Entrepreneur's Fund, Smartcap, Contour Venture Partners and Primary Venture Partners, as well as several angel investors.

In 2017, Rakuten Fits Me started providing its online fitting service called Fit Origin that provides a personalized sizing recommendation for online customers.[347] When using Fit Origin, customers themselves specify their height, weight, age, bust and body shape to have the recommendation engine determine the best possible fit for each of the merchant's garments.

Probably the most advanced body measurement technology currently available for online customers in Japan is the one called "Zozosuit" provided by the Japanese fashion company Start Today, which runs Japan's largest online fashion retail store ZOZOTOWN.

Table 8.2 Zozosuit
In 2017, Start Today started providing its online customers with a smart bodysuit called Zozosuit. Consisting of tops and bottoms, Zozosuit has stretch sensors that instantly allow users to measure their body. By placing a smartphone in front of it, a customer's body measurement data can be transferred via Bluetooth from the outfit to the Zozotown mobile app. Zozosuit is provided by Start Today to

[345] The press release as of 13th July 2015 published by Rakuten Fits Me: https://fits.me/2015/07/13/rakuten-acquires-fits/.

[346] The press release as of 13th July 2015 on the website of *estonian world*: http://estonianworld.com/technology/estonian-founded-fits-me-sold-to-japanese-e-commerce-giant-rakuten/.

[347] The press release as of 31st July 2017 published by Rakuten: https://rakuten.today/blog/perfect-fit-online-fashion-rakuten-fits-me-new-service.html.

customers for free with the aim of promoting Start Today's first made-to-order clothing brand "Zozo."[348] This state-of-the-art technology was jointly developed by a sensing technology venture StretchSense, a spin-out from the Biomimetics Lab of the Auckland Bioengineering Institute, University of Auckland in New Zealand. Start Today and StrechSense reached a call option agreement in 2017.[349]

Photo from the ZOZOTOWN website[350]

Other Japanese fashion companies, including Japan's largest fashion company Fast Retailing, see a large potentiality in the growth of the online made-to-order clothing market. In this respect, demand for cutting-edge body measurement technology for online customers, such as the one developed by StrechSense, will continue to increase in Japan.

8.2 Knowledge transfer opportunities in the field of AI technology for fashion trend analytics

AI technology for tracking and analyzing fashion trends and generating fashion recommendations has recently captured attention in the fashion industry in Japan. For example, Sensy, a spin-off venture from Keio University in Japan, has provided online fashion

[348] The press release as of 31st January 2018 published by ZOZOTOWN: https://www.starttoday.jp/en/news/20180131-3560/.

[349] The press release as of 22nd November 2017 published by StrechSense: https://www.stretchsense.com/article-resources/press/stretchsense-negotiates-call-option-agreement-with-starttoday/.

[350] Available at: http://zozo.jp/shop/zozo/goods/25782997/.

recommendation services using an AI-based application named "Sensy."[351] Users of the service download the free Sensy application and sort out whether they like the images of wear sent to their smartphones once a day. The AI system in the application analyzes replies from the user in accordance with color, shape, price and 47 other criteria to find out that person's taste. By continuing this process, the AI system in the application learns the user's preference and generally improves a recommendation's accuracy. Sensy has tied up with more than 2,000 fashion companies and online commercial sites both at home and abroad for women in their 20s and 30s. Out of a huge number of dresses introduced on the Internet, the AI system recommends clothes to each user based on accumulated data. If the user finds any favorite fashion item to buy in the recommendation, he or she may easily jump into an online store via the app selling that item. When users purchase recommended clothes, sellers pay commissions to Sensy.

The utilization of AI for fashion trend analytics is also capturing in Europe and the US. For example, in the paper titled "FashionBrain Project: A Vision for Understanding Europe's Fashion Data Universe,"[352] a group of researchers from European institutes, including the University of Sheffield in the UK, Beuth University of Applied Sciences Berlin in Germany, and University of Fribourg in Switzerland, discussed ways the massive amount of fashion data available on social media sites such as Instagram and Pinterest could be used to detect and predict trends and recreate the online-shopping experience.

Japanese fashion companies are now paying their particular attention to Amazon's AI technology for fashion trend analytics. In February 2016, Amazon unveiled the Echo Look, a camera that has the company's Alexa intelligent assistant built in. The Echo Look can snap pictures of a customer and then use its artificial intelligence to help him or her find matching clothes for the ones he or she is wearing, such as jacket to go with his or her shirt or shoes that would go with his or her pants.

Also, according to MIT Technology Review published in August 2017, Amazon's AI experts are working on the following two kinds of AI technology for fashion trend analytics.[353]

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[351] The website of Sensy: https://sensy.ai/.

[352] Available at: https://kddfashion2017.mybluemix.net/final_submissions/ML4Fashion_paper_15.pdf.

[353] Will Knight, "Amazon Has Developed an AI Fashion Designer," 24th August 2017, *MIT Technology Review*. Available at: https://www.technologyreview.com/s/608668/amazon-has-developed-an-ai-fashion-designer/.

Table 8.3 Amazon's AI technologies for fashion trend analytics	
AI for fashion feedback	The group of Amazon researchers based in Israel developed a machine learning system that, by analyzing just a few labels attached to images, can deduce whether a particular look can be considered stylish. This system provides fashion feedback or recommendations for adjustments. The innovativeness of this system can be seen in the fact that computers usually require extensive labeling in order to learn from visual information, while, in many real-world situations, such as an image posted to Instagram, there might be just one label.
AI fashion designer	An Amazon team at Lab126,[354] a research center based in San Francisco, has developed an algorithm that learns about a particular style of fashion from images, and can then generate new items in similar styles from scratch, essentially functioning as a AI fashion designer. This technology uses a cutting-edge tool called a generative adversarial network (GAN).[355] It consists of two deep neural networks operating in tandem to learn efficiently from raw data. The GAN internalizes the properties of a particular style simply by looking at lots of examples, and it can then apply that style to an existing item of clothing.

These kinds of AI technology for fashion trend analytics have already gained attention from Japanese fashion companies. European ventures with cutting-edge technology in this area will surely see chances to have technology alliance with Japanese fashion companies in this respect.

8.3 Knowledge transfer opportunities with Japanese universities in the field of emotional design for fashion

In the Japanese academia, how to use cutting-edge IT for various aspects of fashion business has mainly been discussed in the field of emotional design. Generally speaking, emotional

[354] The website of Amazon Lab126: https://www.lab126.com/.

[355] Generative adversarial networks (GANs) are deep neural net architectures comprised of two nets, pitting one against the other (thus the "adversarial"). GANs were introduced in a paper written by Ian Goodfellow and other researchers at the University of Montreal in 2014. GANs can learn to mimic any distribution of data in any domain: images, music, speech, and prose.

design or affective engineering (sometimes called “Kansei” engineering in Japan) aims at the development of products and services by translating the customer's psychological feelings and needs into the domain of product design. Emotional design parametrically links the customer's emotional responses (i.e. physical and psychological) to the properties and characteristics of a product or service. As a result, products can be designed to bring forward the intended feeling.

There are an increasing number of researchers engaging in a diverse area of emotional (or Kansei) design studies, including studies of the application of emotional design technology to fashion design. The following is a list of major Japanese universities that have a research center in the field of emotional (or Kansei) design.

Table 8.4 Example of a Japanese university engaging in the research on emotional design technology for fashion design

- Shinshu University
  - Division of Kansei and Fashion Engineering: http://www.shinshu-u.ac.jp/institution/ifes/english/division/kfe.html
  - Two professors from the UK (one professor is from Heriot-Watt University, while the other professor is from the University of Liverpool) are currently doing research work as a visiting professor at this division of Shunshu University.
- University of Tsukuba
  - Graduate School of Comprehensive Human Sciences: http://www.kansei.tsukuba.ac.jp/en/
- Kyushu University
  - Department of Kansei Science: http://www.ifs.kyushu-u.ac.jp/pages/eng/kss_01.html
  - In the area of emotional design in connection with taste and odor sensing, Kyushu University has a research center called Research and Development Center for Taste and Odor Sensing: http://www.rdctos.kyushu-u.ac.jp/.

The largest academic society in the field of emotional (Kansei) design is Japan Society of Kansei Engineering.[356]

[356] The website of Japan Society of Kansei Engineering: https://www.jske.org/.

9. IT for Art and Music Business

9.1 Knowledge transfer opportunities in the area of blockchain technology for transactions of copyrights

Copyrighted works, the issue of "value gap," and blockchain

In terms of promoting the digital use of copyrighted works, the issue of the "value gap" has been discussed for some time. The question here is whether authors and rights holders can sufficiently benefit from the revenues generated by the use and the display of their works on online platforms.[357]

In this regard, blockchain technology can play an important role in establishing a decentralized copyright management system to solve this "value gap" issue.[358] This idea is based on the storage of creative works as well as their metadata in a comprehensive blockchain. This would make it possible to track the distribution of digital content in real time and to verify authorizations. The authenticity of a work can be confirmed even after it is circulated in the online market. Blockchain-based cryptocurrencies such as Bitcoin and Ethereum can support micropayments between artists and consumers. In this way, blockchain technology offers options for the traceability of the license chain to the author, thereby facilitating his or her participation in the revenue generated on the Internet.

The importance of blockchain technology for the music industry

The importance of blockchain technology for the management of music copyrights can be seen in the case where Spotify acquired the US-based blockchain startup Mediachain Labs in 2017 with the aim of co-developing better technology for connecting artists and other rights holders with the tracks hosted on Spotify's service.[359]

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[357] The European Commission has addressed this issue within the framework of its strategy for a Digital Single Market, more specifically in its draft for the Directive on copyright in the digital single market. See the website of the European Commission: https://ec.europa.eu/commission/priorities/digital-single-market_en.

[358] The fact that blockchain technology can be effectively used for the management of intellectual property rights has been hotly discussed around the world. For example, see the website of WIPO: http://www.wipo.int/wipo_magazine/en/2018/01/article_0005.html.

[359] The press release as of 26 April 2017 published by Spotify: https://press.spotify.com/us/2017/04/26/spotify-

The problem for Spotify is that they may try to pay artists and publishers but often do not have the information on know who to pay. This is perhaps more of a problem with smaller artists or indie labels. In fact, in 2017, Spotify reached a USD 30 million settlement with a publishing group over unpaid royalties and agreed to establish best practices to match all music streams with copyrights holders. Now Spotify is utilizing the blockchain technology developed by Mediachain Labs to establish a more fair and transparent management system of music copyrights within its business structure.

In Japan, Avex Group Holdings, one of Japan's largest music entertainment companies, has shown interest in investing, through its venture capital arm called Avex Ventures, in a blockchain-based system for digital music copyright management.[360]

European ventures creating blockchain-based copyright management systems

While the interest in the blockchain-based copyright system is rapidly increasing in Japan, the three ventures mentioned in the table below have received some media coverage in Japan.

Table 9.1 Examples of foreign ventures that have created blockchain-based copyright transaction systems

Ascribe (Germany)	Ascribe is a Berlin-based startup that is using blockchain technology to timestamp intellectual property and create a sustainable ownership structure for artwork and other digital media.[361] Using blockchain technology, Ascribe allows artists to create records of permanent and unchangeable copyright and ownership of their artwork that can be verified and tracked instantly. Since the data and copyright cannot be changed once it is registered on the blockchain, artists will be able to defend their works without the need to spend money on the traditional process of hiring lawyers to create legal documents. According to the company, more than 600 artists have already signed up for access, and over 2,600 works of art have been registered. Several marketplaces and platforms are also using Ascribe's API to display the copyrights to the artwork. Ascribe is

acquires-mediachain-labs/.

[360] See the website of Avex Ventures: http://avexventures.co.jp/.

[361] The website of Ascribe: https://www.ascribe.io/

	currently in progress of designing a machine learning technology which will be able to search through the web to classify copied works without watermarks. Ascribe is now in partnership with Recruit (see Table 4.13 above).
Ujo Music (UK)	Ujo Music is a London-based startup that provides musicians with an online infrastructure where artists can publish their music independently, irrespective of any major labels and music publishers, and can then define and manage their own marketing and exploiting information.[362] At the same time, a payment infrastructure is available in the test phase. The author of the piece of music determines the price for a download, a commercial remix or the use by music portals. The payment on the Ujo Music platform can be done via the cryptocurrency Ether. All transactions and splits can be tracked in the blockchain-based platform.
PeerTracks (Canada)	PeerTracks is a music streaming, music retail, talent discovery and fan engagement platform that leverages the use of blockchain technology.[363] This platform enables artists to retain 95% of the funds generated from sales, which do not need to pass through PeerTracks at all; funds are sent directly from fan to artist through the peer-to-peer payment network called the MUSE Blockchain. Income is also automatically split between all copyright holders, which are paid within seconds. In the platform, artists can determine the conditions under which their songs can be used. And, in the platform, artists can create their own "Notes," which are tradable VIP passes into the artist's world. Holders of the Notes receive special products, such as a special recording or a backstage pass for a concert. As the popularity of the artists grows, the value of the Notes grows.

9.2 Knowledge transfer opportunities in the field of AI for music composition

Music is often enjoyed and sought for its ability to induce or convey emotions, which may manifest in anything from a slight variation in mood to changes in our physical condition and actions. Consequently, research on how music can be associated with emotions or how music

[362] The website of Ujo Music: https://ujomusic.com/.

[363] The website of PeerTracks: https://peertracks.com/.

brings about an emotional response is attracting ever increasing attention. And, how to utilize AI for composing emotional music has recently been a hot topic in this context.

For example, Google is now promoting a project called Magenta with the aim of exploring the role of machine learning in the process of creating music and art. This project's current primary focus is on developing new deep learning and reinforcement learning algorithms for generating songs, images, drawings, and other materials.[364]

Sony Computer Science Laboratory (CSL) in Paris, which is a sister laboratory of the Sony Computer Science Laboratories in Tokyo and directed by Professor Vittorio Loreto at Sapienza University of Rome, is developing a system of algorithms which can create songs that cater to the user's taste, based on styles adapted from existing music.[365] In this system, the user can choose, from a database of sheet music of more than 13,000 existing songs, any number of titles with a sound or feel they would like the new song to incorporate. The algorithm then analyses the songs' characteristics, and statistical properties related to rhythm, pitch and harmony. It will learn, for instance, which notes "go well" with a given chord, what chord is probable after a given chord, or which notes usually follow after a given note. Based on the emerging pattern, the algorithm creates a partition or lead sheet with similar characteristics.

The London-based venture JukeDeck has developed the artificial intelligence music composition technology that allows users to create music simply by selecting the mood, style, tempo, and length they need to match their footage.[366] This technology can significantly lower cost and save time in video production. JukeDeck's service based on this technology allows independent video makers to make their first five songs for free, followed by a fee of USD 7 per track following it. Larger businesses will be charged USD 15 per track. Exclusive copyright for the composition can be purchased for USD 150.

The New York-based venture Amper Music has developed a similar AI technology for music composition.[367] With Amper's technology, individuals and businesses can craft and customize

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[364] The website of Magenta: https://magenta.tensorflow.org/.

[365] The website of Sony Computer Science Laboratory (CSL) in Paris: https://www.csl.sony.fr/.

[366] The website of JukeDeck: https://www.jukedeck.com/.

[367] The website of Amper: https://www.ampermusic.com/.

original music for any and all media content from video to gaming, without needing any prior music experience. Users simply select a sentiment they want to convey and the desired length of the track and then hit "Render." The AI then delivers a composition based on these categories in just a few seconds. The music created with Amper's technology comes with a global, royalty-free, and perpetual license, avoiding the many legal and financial hurdles of traditional music licensing. In this way, Amper's technology enables media content creators to simplify their workflow.

The University of Málaga in Spain is a world-famous research center in the field of AI for music composition. A group of researchers at this university has created a computer system called Melomics that uses what is called nonconventional evolutionary algorithms to compose music without human intervention.[368]

In Japan, two companies, namely LINE, which is the major provider of the freeware application called "LINE" for instant communications on electronic devices such as smartphones, and Yamaha, which is a Japanese multinational company that provides musical instruments, electronics and power sports equipment, have been collaborating with each other.[369] They are now combining Yamaha's VOCALOID voice synthesis technology[370] and LINE's Clova cloud AI technology for the development of AI-based technology for composing music.

In addition, a group of researchers from Japanese universities and IMEC (Interuniversity Microelectronics Centre) in Belgium has developed an AI-based system that performs automatic music composition based on brain responses to music, as shown in the table below.

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[368] The website of Grupo de Estudios en Biomimética at the University of Málaga: http://www.geb.uma.es/melomics/melomics.html.

[369] See the information on the website of Line: https://linecorp.com/en/pr/news/en/2017/1772

[370] VOCALOID enables users to input melody and lyrics in order to synthesize a singing voice. In other words, with this technology, singing can be produced without a singer.

Table 9.2 COI program in collaboration with IMEC

Project members: Osaka University (Japan), Tokyo City University (Japan), Crimson Technology (Japan), and Interuniversity Microelectronics Centre or IMEC (Belgium)

Description of the project

Within the framework of Osaka University's Center of Innovation (COI) program supported by the Japan Science and Technology Agency,[371] a group of researchers from Osaka University, Tokyo City University, the Japanese music technology company Crimson Technology as well as IMEC (Interuniversity Microelectronics Centre) in Belgium succeeded in developing an AI-based system that performs automatic music composition based on brain responses to music.[372]

In this system, the user listens to music while wearing headphones with brain wave sensors. The AI system integrated with headphones collects the wearer's brain data on music and learns the relationship between the wearer' response to collected songs and their brain waves. It then produces, in real-time through Musical Instrument Digital Interface (MIDI) technology, unique music that fits the wearer's preferences and influences his emotions to achieve the wearers' desired emotional state. Conventional music recommendation systems only recommend songs similar to those users listened to before. And, conventional automatic music composition systems require users to specify characteristics of a song to be composed in detail, both of which are difficult to link to reactivation of the brain.

This newly developed AI technology is expected to make it possible to measure response of individuals as well as those of the audience in the future. This technology could also be utilized for societal benefits, for example in health care to motivate people to exercise or cheer them up. This device integrated with autonomous music composition software was exhibited in the third Wearable Expo 2017 in Tokyo.

[371] The website of Osaka University's COI project: https://www.coistream.osaka-u.ac.jp/en.

[372] The news release as of 1st January 2016 published by Osaka University: http://resou.osaka-u.ac.jp/en/research/2017/20170116_1. Also see the press release as of 9th January 2018 published by IMEC: https://www.imec-int.com/en/articles/imec-and-holst-centre-introduce-eeg-headset-for-emotion-detection.

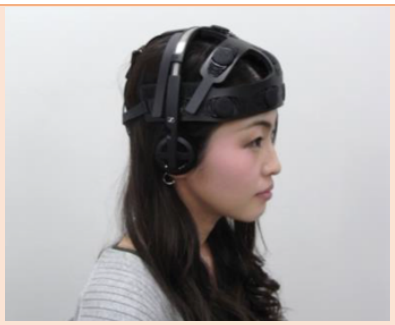

Photo from the website of Osaka University.[373]

9.3 Knowledge transfer opportunities with Japanese universities in the field of AI for the creation of artistic work

In addition to Osaka University mentioned above, there are several other Japanese universities that have engaged in the study of the application of AI for the creation of artistic work, including the composition of music, as mentioned in the table below.

Table 9.3 Japanese universities engaging in the research on the application of AI for art creation

- Tokyo University of the Arts
  - Arts & Science Laboratory: http://innovation.geidai.ac.jp/en/index.html
  - This lab has been run within the framework of Tokyo University of the Arts Center of Innovation (COI).
- Future University Hakodate
  - Hitoshi Matsubara Laboratory (Japanese): https://www.fun.ac.jp/research/faculty_members/hitoshimatsubara/
  - Professor Hitoshi Matsubara is currently the former president of the Japanese Society for Artificial Intelligence.[374]
  - A team of team of computer scientists led by Professor Matsubara has engaged in utilizing AI-based computers to write fiction. They gained media coverage inn 2015, when a novel work created by the AI system passed the first round of screening at a novel-writing contest in Japan.

[373] Ibid.

[374] The website of the Japanese Society for Artificial Intelligence: https://www.ai-gakkai.or.jp/.

Conclusion

This report provided some vital information that may help EU entities build up knowledge transfer strategies with Japanese counterparts in the nine digital technology areas. This final section will provide several additional notes for the promotion of knowledge transfer from EU entities to Japanese companies.

1. Knowledge transfer with Japanese companies

The importance of competition strategy against rivals

As shown in this report, there are a growing number of opportunities for venture firms, universities and research institutes in the EU to conduct knowledge transfer with Japanese counterparts in all the nine digital technology areas analyzed in this report. In each of the nine digital technology fields, there are Japanese companies that have strong motivation and technology insight to invest in or ally with high-tech ventures around the world with the aim of upgrading their competitiveness and expanding their business not only in the Japanese market but also in the global market.

On the other hand, whenever there is a promising technology area for EU entities' knowledge transfer with Japanese counterparts, that technology area is almost always a promising one for entities in other countries in the same respect. In other words, there is no IT field that is promising only for EU entities' knowledge transfer with Japanese counterparts. Therefore, it is always necessary for EU entities to carefully consider what competitive advantages their technologies can bring to possible Japanese counterparts as a matter of their competition strategy against potential rivals.

As shown in this report, in all the nine digital technology areas, US entities will be the strongest rivals against EU entities in terms of conducting knowledge transfer with Japanese companies. Many key Japanese companies are paying keen attention to innovations generated by emerging ventures and top-ranking universities in the US. Some of those Japanese companies have established their corporate venture arms and/or R&D hubs in Silicon Valley to monitor newest technology developments and approach promising ventures and research institutes in the US

(examples in this regard can be seen Sections 1.6, 1.7 and 1.8). Knowing what US rivals are doing and how potential Japanese partners are approaching them in the targeted technology area(s) will always give EU entities vital benchmark information on how to formulate and implement their alliance strategies for possible Japanese counterparts.

Israeli ventures are also very active in partnering with Japanese counterparts in areas such as automated driving, cybersecurity, and blockchain (Sections 1.6, 1.10, 2.6, 2.9 and Table 1.18). The Israeli embassy in Tokyo has strongly pushed cutting-edge Israeli ventures in large business matching events in Japan including Cybertech Tokyo (Section 2.12). Also, increasing Japanese media coverage regarding Israel's capacity of generating many innovative IT ventures has contributed to the spreading of Israel's national brand as the "Startup Nation" or "Cyber Nation" among key industry opinion leaders in Japan,[375] and has resulted in keen attention being paid by Japanese investors to the high potentiality of Israeli ventures in diverse IT areas.

Chinese ventures can also be strong rivals against EU entities in terms of knowledge transfer with Japanese counterparts (Section 3.6, Tables 1.11, 4.17 and 5.4). China is rapidly emerging as one of the world's hotbeds for AI talents. A growing number of internationally competitive AI ventures have been created in China. American tech conglomerates such as Google, Microsoft and Amazon are all eagerly hiring AI talents in China.[376] The rapid growth of AI in China can be partly attributed to government initiative. In 2017, the Chinese government outlined plans to become a world-leader in AI by 2025, laying down a challenge to US dominance in the sector.[377]

Needless to say, competition also occurs among EU entities themselves. The EU entities mentioned in this report can all be rivals for other EU entities wishing to conduct knowledge

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[375] For example, Mr. Idei, Sony's former CEO, is a famous Japanese influencer in support of the innovativeness of Israeli ventures in diverse IT fields. He was one of the main speakers at Israel-Japan Business Forum that took place in Tokyo in November 2017. The website of the Forum (Japanese): https://www.jetro.go.jp/events/bda/f64dea5867ddd063.html.

[376] Yuyu Chen, "China emerges as a hotbed for artificial intelligence," 2nd January 2018, *Digiday*. Available at https://digiday.com/marketing/china-emerges-hotbed-artificial-intelligence/.

[377] Adam Jourdan, "China aims to become world leader in AI, challenges U.S. dominance," 20th July 2017, *Reuters*. Available at: https://www.reuters.com/article/us-china-ai/china-aims-to-become-world-leader-in-ai-challenges-u-s-dominance-idUSKBN1A5103.

transfer with Japanese counterparts in the targeted technology area(s). In addition, while mentioning many examples of West European ventures that have partnered with or are attracting or may attract attention from Japanese counterparts, this report has also showed examples of East European ventures that have partnered with or are attracting or may attract attention from Japanese counterparts.

In this regard, East European countries' high capacity and potentiality for generating many cutting-edge IT ventures are increasingly gaining popularity in Japan. The most notable example is Estonia (Sections 2.8 and 4.11, Table 8.1). Other examples of "East European IT nations" that are capturing attention in Japan are Poland,[378] Romania,[379] Hungary,[380] and Lithuania.[381] Brexit may give a boost to those emerging IT nations.[382] In terms of effectively upgrading their nation brand as a growing IT capital in Europe and successfully conducting knowledge transfer with Japanese counterparts, it will be of vital importance for emerging East European economies such as these to further intensify their outreach activities towards the key Japanese players in industry, government and academia.

Finally, in terms of conducting knowledge transfer with Japanese counterparts, EU entities may often face Japanese rivals. Some of the Japanese companies mentioned in this report will certainly be a good partner with EU entities, while others can be a strong rival against EU entities in terms of conducting knowledge transfer with the targeted Japanese counterparts. It is always important to figure out "who is a friend or foe" in the targeted technology area.

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[378] Alison Coleman, "Poland On Track To Becoming A Major European Tech Startup Hub," 20th May 2016, *Forbes*. Available at: https://www.forbes.com/sites/alisoncoleman/2016/05/20/poland-on-track-to-becoming-a-major-european-tech-startup-hub/#22d0eb322085.

[379] Andrew Macdwall, "How Romania became a popular tech destination," 19th September 2017, *Financial Times*. Available at: https://www.ft.com/content/a0652dba-632f-11e7-8814-0ac7eb84e5f1. Also see the website of Romanian Startups: http://www.romanianstartups.com/.

[380] Alison Coleman, "How Prezi Helped Turn Budapest Into Europe's Newest Startup Hub," as of 7th November 2014, *Forbes*. Available at: https://www.forbes.com/sites/alisoncoleman/2014/11/07/how-prezi-hungarys-vc-trojan-horse-helped-turn-budapest-into-europes-newest-start-up-hub/#6acd6d92aa67.

[381] The article "Fintech is King of Lithuania's Tech Revolution" as of 4th June 2017 on the website of *Red Herring*: https://www.redherring.com/startups/fintech-king-lithuanias-tech-revolution/.

[382] Emma Rumney, "Lithuania's 'fintech' drive gets a Brexit boost," 2nd December 2017, *Reuters*. Available at: https://www.reuters.com/article/uk-fintech-lithuania/lithuanias-fintech-drive-gets-a-brexit-boost-idUSKBN1DV5BA.

Venture capitals, venture acceleration programs, pitch contests, business matching events and industry associations

This report indicated examples of corporate venture capitals created by large companies as well as independent venture capitals in Japan that are active in investing in ventures around the world. It is a vital option for EU ventures to directly contact them in terms of gaining opportunities for funding and knowledge transfer.

This report also showed events and programs through which EU ventures may efficiently approach potential Japanese partners and investors. For example, this report mentioned three kinds of venture acceleration programs to which EU ventures can apply:

1. the venture acceleration programs in Japan that target at foreign as well as domestic ventures (Section 3.9);
2. the venture acceleration programs in Japan that target specifically at foreign ventures (Fintech Business Camp Tokyo in Section 3.9 and Blockchain Business Camp Tokyo in Section 4.15); and
3. the venture acceleration programs run by Japanese entities in the EU with the aim of investing in or allying with EU ventures, namely Honda Xcelerator in Europe (Section 1.8) and Gumi's Nordic VR Startups (Table 7.3).

Those programs can be a good opportunity for EU ventures to reach out to potential Japanese partners and investors. It is of strategic importance, from a viewpoint of the EU's innovation policy, to increase the number of these kinds of Japan-sponsored venture acceleration programs through which EU ventures can have direct contact with potential Japanese partners and investors.

Also, this report showed several examples of major business marching events in Japan that allow EU high-tech ventures to apply and showcase their innovative technologies (Sections 2.12 and 3.9). In addition to those examples, there are several other large-scale business matching

events in Tokyo for ventures around the world, such as Slush Tokyo,[383] TechCrunch Tokyo,[384] and Tech in Asia Tokyo.[385]

As shown in this report, industry associations such as Fintech Association of Japan (Section 3.10) and Blockchain Collaborative Consortium (Section 4.13) have been active in partnering with industry associations in other countries. Creating networks between European and Japanese industry associations will surely lead to the facilitation of knowledge transfer from EU entities to potential Japanese counterparts (as well as from Japanese entities to EU counterparts).

2. Creating networks with Japanese universities and research institutes

The importance of networks with Japanese universities and research institutes

Establishing networks with Japanese universities and research institutes may provide ventures, universities, and research institutes in the EU with precious opportunities, among others, to:

- co-develop cutting-edge technologies;
- approach potential Japanese partners, including university spin-offs, private venture capitals, and public funding agencies such as JST[386];
- raise revenue from the commercialization of the co-developed high-quality technologies in the Japanese market as well as in the global market.

This report mentioned several examples of Japanese universities and research institutes that could be a partner for EU entities in each of the nine digital technology fields. Among them, ITS Center of the University of Tokyo (Section 1.17), INCS-CoE led by Keio University

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[383] The website of Slush Tokyo: http://tokyo.slush.org/.

[384] The website of TechChurch Tokyo: https://jp.techcrunch.com/event-info/techcrunch-tokyo-2017/.

[385] The website of Tech in Asia Tokyo: https://www.techinasia.com/events/tokyo.

[386] Japan Science and Technology Agency or JST is one of the largest government funding agencies under the auspices of the Ministry of Education, Culture, Sports, Science and Technology of the Japanese government. JST engages in the top-down promotion of various research projects at universities and research institutes. JST promotes international joint research, among others. See the website of JST: http://www.jst.go.jp/EN/operations/operation_d.html.

(Section 2.13), the CoI program led by Osaka University (Section 9.2) have already networked with EU entities. Base-Alliance co-promoted by the University of Tokyo, Keio University and MIT in the US will function as a R&D hub for blockchain technology development with EU entities (Section 4.14).

And, here again, cutting-edge ventures and top-tier universities and research institutes in the US will be the strongest rivals against EU entities in terms of facilitating knowledge transfer with Japanese universities and research institutes. It is always important for EU entities to consider what competitive advantages they can bring to their Japanese counterparts in the research community.

AI research centers in Japan

This report showed that the application of AI is one of the most promising areas for knowledge transfer from EU entities to Japanese counterparts in all the nine digital technology areas. On the other hand, the potentiality of AI is certainly not limited to those nine areas. The technology areas where AI can be applied are extremely diverse and still expanding. Many countries have put the top priority on the advancement of AI technology as a matter of their science and innovation policies as well as industry promotion policies. This applies to Japan as well, as has manifested in its vision of Society 5.0 (Table 1.2 above).

In line with the global AI momentum, AI research centers have been created within major Japanese universities and national research institutes. There will be chances for cutting-edge ventures, universities and research institutes in the EU to conduct knowledge transfer/sharing with those AI research centers in Japan. The table below shows examples of major AI research centers in Japan.

Examples of AI research centers in Japan
• The University of Tokyo ➢ Next Generation Artificial Intelligence Research Center: http://www.ai.u-tokyo.ac.jp/index-e.html • University of Tsukuba ➢ Center for Artificial Intelligence Research: https://air.tsukuba.ac.jp/

- Osaka University
  - Graduate School of Information Science and Technology: http://www.ist.osaka-u.ac.jp/english/
- Tohoku University
  - Graduate School of Information Sciences: https://www.is.tohoku.ac.jp/en/
- The University of Electro-Communications
  - Artificial Intelligence eXploration Research Center: http://aix.uec.ac.jp/
- National Institute of Advanced Industrial Science and Technology (AIST)
  - Artificial Intelligence Research Center (AIRC): http://www.airc.aist.go.jp/en/
  - AIRC has now been in partnership with Manchester University in the UK and DFKI in Germany, among others.
- Riken
  - Center for Advanced Intelligence Project: http://www.riken.jp/en/research/labs/aip/
- National Institute of Information and Communications Technology (NICT)
  - AI Science R&D Promotion Center: http://www2.nict.go.jp/ais/index.html

3. Knowledge transfer through cluster collaborations between the EU and Japan

Creating networks between knowledge-intensive clusters in different countries can facilitate knowledge transfer and sharing among various entities belonging to those clusters, which will lead to mutually accelerating the process of innovation and upgrading the international competitiveness of those clusters as a whole. This is particularly true in this digitally interconnected world, which enables easier information exchange and generates shared advantages through the aggregation of expertise and specialized resources even between the clusters remotely located from each other.

It should be a vital element of EU innovation policy, therefore, to promote networks and collaborations between promising knowledge-intensive clusters in the EU and Japan. Facilitating partnership with competitive IT clusters in Japan will bring benefits not only to long-standing IT clusters in West Europe such as London, Berlin, Paris, Amsterdam, Stockholm

and Helsinki, but also to emerging IT capitals in East Europe such as Warsaw (Poland), Bucharest (Romania), Budapest (Hungary), and Vilnius (Lithuania) as well.

This report showed three examples of partnerships between Japanese and European IT clusters, namely the partnership between London and Tokyo (Section 3.11), the partnership between Oulu City in Finland and Sendai City in Japan (Section 7.10), and the partnership between Fukuoka City in Japan and three European cities (Section 7.10). Another example of ongoing EU-Japan cluster collaboration initiative is the one between the State of Thuringia in Germany and Hamamatsu City in Japan with the aim of co-promoting their photonics clusters.[387]

As far as promising IT clusters in Japan are concerned, Fukuoka City has been successful in promoting itself as an international IT hub under the campaign of "Startup City Fukuoka," having partnered with IT hubs in Estonia, Finland and France (Section 7.10).

Another Japanese city that has high research capacity and business incubation potentiality as a partner city for European IT clusters is Tsukuba City. Located about 50 km northeast of Tokyo, Tsukuba City has functioned as one of the largest and most vital research centers in Japan. 32 national research institutes and more than 130 private research institutes are located in Tsukuba City, where a total of more than 20,200 researchers work and about 220,000 people including foreign researchers and their families, as well as students reside.[388] At the core of the research capacity of Tsukuba City is the University of Tsukuba, which has been mentioned in this report several times (Sections 1.26, 2.11, 5.10 and 8.4, and the above-mentioned table regarding major AI research centers in Japan). Through its continuous efforts and strong initiatives, the University of Tsukuba has attracted innovative scientists and researchers in diverse areas from all over the world. One recent example of the initiatives taken by that university in this regard is

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[387] Source: the presentation material titled "Hamamatsu and Thuringia: the success story of a photonics cluster collaboration," which was submitted at the symposium "Regional Innovation and Cluster Collaborations" that took place in Tokyo under the initiative of the German Research Innovation Forum on 20th September 2017. Available at: http://www.dwih-tokyo.jp/fileadmin/customer/dwih/events/20170920_Cluster_Symposium/Mank_Keynote.pdf. For the flyer of that symposium, see: http://www.dwih-tokyo.jp/fileadmin/customer/dwih/events/20170920_Cluster_Symposium/Flyer_Cluster_Symp_low.pdf.

[388] The website of Japan National Tourism Organization: https://www.jnto.go.jp/eng/regional/ibaraki/tsukuba_science_city.html.

the Tsukuba Global Science Week (TGSW), which it organizes in September every year.[389] In TGSW 2017, a total of 46 sessions were held, and more than 1,800 researchers at 160 research organizations in 48 countries gathered in Tsukuba City. In addition, the University of Tsukuba will organize a conference called "Tsukuba Conference" once every two years from 2019 with the aim of attracting promising young researchers from all over the world to the conference and upgrading the international popularity of Tsukuba City as a global innovation hub.[390]

Kobe City, which is located in the Kansai area of Japan, is also a good candidate as a partner city for European IT clusters. Kobe City is now transforming itself into an international IT innovation hub by attracting ventures around the world to its government-sponsored IT business incubation schemes, including the business model contest called "Kobe Global Startup Gateway"[391] and the venture acceleration program called "500 Kobe Accelerator" that the Kobe City Government has run in collaboration with the Silicon-Valley-based venture capital 500 Startups.[392] Alongside with the glowing IT cluster, the Kobe City Government has run the Kobe Biomedical Innovation Cluster (KBIC), which is one of the largest medical research clusters in Japan, featuring more than 330 medical companies engaged in cutting-edge medical research and development.[393]

Finally, again, in view of the fact that a growing number of competitive IT clusters around the globe are now trying to attract investment and talents from Japan, it is of crucial importance for EU clusters to consider what competitive advantages they can bring to their potential target cluster(s) in Japan.

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[389] The website of Tsukuba Global Science Week: http://www.kokuren.tsukuba.ac.jp/TGSW2017/.

[390] *Mainichi Shimbun*, the article as of 13th May 2017 (Japanese). Available at: https://mainichi.jp/articles/20170513/ddl/k08/040/243000c.

[391] The website of Kobe Global Startup Gateway: http://kobe.globalstartupgw.com/en/.

[392] The website of 500 Kobe Accelerator: http://500kobe.com/.

[393] The website of Kobe Biomedical Innovation Cluster: http://www.kobe-lsc.jp/en/.

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