Ministry of Economic Affairs
and Climate Policy

ARTIFICIAL INTELLIGENCE IN JAPAN 2020

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ARTIFICIAL INTELLIGENCE IN JAPAN 2020

ACTORS, MARKET, OPPORTUNITES AND DIGITAL SOLUTIONS IN A NEWLY TRANSFORMED WORLD.

Autor   Nicole Dirksen
Co-author   Sonoko Takahashi

5 October 2020

Embassy of the Kingdom of the Netherlands
Innovation, Science and Technology

info@hollandinnovation.jp

CONTENTS

Cover picture form Go Tokyo

LIST OF FIGURES

SUMMARY

AI is booming, especially in Japan. This rapport will introduce the Japanese AI situation, the relevant actors, the market, its policy ambitions, its challenges and of course opportunities for the Netherlands. Japans AI ecosystem exists of investments from the public and private sector combined, supporting a research environment in which AI can flourish. The Japanese government, coordinated by the Cabinet Office, is aided by the Council for Science, Technology and Innovation and the Strategic Council for AI Technology. The execution of their AI policies is divided over three ministries: Internal Affairs and Communication, Economy, Trade and Industry and Education, Culture, Sports, Science and Technology. Looking at the private sector, three big Japanese industries can be distinguished to be very active in AI-related developments: the automotive, robotics and electronics industries. Among these industries several different types of intersectoral and international relationships can be found. Of these three sectors, the automotive industry spends the most on R&D.

The AI market can be concluded to be opportune. The global AI market estimated compound annual growth rate between 2018 to 2025 differs from 33% to 55%. By 2025, the AI global market is projected to be worth between 156 and 360 billion euros. The Asia Pacific region is anticipated to overtake North America's number one spot on the global AI market by 2025. As to date, Japan has 200 to 300 AI-related companies. Japan is number one in the world as a supplier of industrial robots and third, after China and the USA, in AI R&D. On AI patens is Toshiba Japans highest contributor, claiming the world's third spot, right after IBM and Microsoft.

Japan aims to stay a prominent player in the high-tech sector with AI as one of its vital components. Japan wants to utilize AI in its policies to address its own societal issues through its envisioned society of the future named Society 5.0. As AI is named a core technology, it made its way into several policy proposals, like the Japanese Moonshot program, similar to Europe's Horizon2020, and the cross-ministerial Strategic Innovation Promotion Program. SCAIT has developed a strategy especially for AI developments, consisting of three tracks. The first track is productivity, with a focus on the enhancement of creativity and innovative services. The second track is health, *medical care and welfare* coming from the urgent need to respond to its rapid aging society. Finally, the third track, *mobility* aims for everyone to be able to travel freely, safely and environmentally friendly.

Japan faces several societal issues, some of which the Netherlands has shared experiences. A main problem for Japan is its rapid aging society, of which over 40% will be elderly in 2030. This puts pressure on the labor force and healthcare system. This pressure is also an incentive of AI enhanced care robots and industrial robots. Of course, as this rapport is written during the global COVID-19 pandemic, the world has and still is rapidly changing from starting this project to its finalization. Several new developments have spurred in the last months. Related to AI, the pandemic seems to cause in some sector short-term budget cuts, but also sparked AI driven solutions and motivated faster digitalization of traditional physical activities in which AI plays a fundamental role.

As to conclude, despite the pandemic, AI is still booming. Japan provides several opportunities for the Dutch private sector, for governmental institutions to exchange best policy practices and for researcher to broaden their expertise.

INTRODUCTION

Artificial Intelligence, or AI, is already entangled in our ordinary daily activities - like navigating, recommending news articles or setting your alarm clock automatically on workdays - and will play an important part in societies future design. The rapid technological developments and increased interests from national and international governmental institutions, research facilities and of course the private sector, created new opportunities as well as challenges, asking actors to respond and adapt. Japan aims to design the society of the future, by developing a long-term strategy to adapt to the new opportunities that high-tech developments provide. Whereas it used to be common practice to collect information and let humans draw the conclusions from this data themselves, we are now evolving into a society were humans and systems are connected in a virtual space. AI is a key technology able to analyze huge amounts of data and translating it conveniently back to the human users. AI is therefore crucial in transforming the information society to the society of the future, also known in Japan as Society 5.0; *"A human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space."* (Cabinet Office, 2020).

But what do we mean when we say 'Artificial Intelligence'? Due to the multifunctionality of AI technology, the terminology for AI is often intertwined with other concepts. The European Union defines AI as:

'Machines that are able to learn, reason, and act for themselves.'[1]

Within this context, this report focuses on the current situation and therefore on Artificial Narrow Intelligence (ANI). This refers to AI systems which are able to perform specific tasks autonomously, but can only operate within the range of the jobs the technology is programed to do. Even the most complicated AI technology created to date is still ANI, also known as reactive or limited memory machines. ANI also includes AI that makes use of machine learning or deep learning to improve their own performances, like virtual assistants or self-driving cars. ANI is not AI that can function completely like a human being (Artificial General Intelligence) or that possesses self-awareness (Artificial Superintelligence), of which the first is currently still a work in progress and the later a hypothetical concept not likely to be realized in the coming decades (Forbes, 2019). The majority of AI is currently making use of machine learning, based on statistical patterns gathered from large data sets. AI can learn from this data to make predictions and create useful insights (Global Orange, 2020). This ever-increasing amount of data gathered through our devices, sensors and online activities are collected in a virtual space, also known as cyberspace. The data is analyzed by AI and the results are fed back to us in our physical space as well. Examples are the introduction of the self-driving car able to avoid traffic jams or the virtual assistant which can make personalized recommendations. With this AI technology, Society 5.0 aims to meet the specific needs of each individual. The 6th Science and Technology Basic Plan for 2021-2026, a Japanese five-year policy plan directing towards a Society 5.0 (Kuczynska, 2019), will be published this year. Therefore, this year will also mark the end of the Japanese 5th Science and Technology Basic Plan (CSTI, 2015). Looking back at the developments

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[1] As used by the European Union (European Union, 2019).

during the 5th plan and the set of goals for the future, provides insights in possible opportunities and perhaps a closer Japanese-Dutch relationship in the AI field. To provide insights and prepare Dutch actors interested in the Japanese AI developments, this report will highlight the relevant Japanese actors, market and political and economic context. By presenting what the expected developments as well as barriers are, this report provides keynotes for whoever is interested in exploring the prospect of the Japanese AI ambition.

To help those who are newly interested to understand the wide variety of AI-related practices, included below is a quick overview of the most prominent techniques and applications of AI technologies in Japan and examples of AI applications daily used by the average consumer. These techniques are strongly intertwined and support each other's functions, making the diction in some cases seemingly arbitrary. These six were elected as they will be mentioned often in the report:

Machine Learning

At the core of AI and the basis of many of the other examples. This technology makes it possible for a machine to learn and from past experiences and deliver output based on provided data, without being programmed to do so repeatedly.

Example: Google calculating travel time based on live traffic data

Deep Learning

Deep learning is a more complicated version of machine learning, stacking multiple layers of algorithms between the input and output layer. This makes it possible for deep-learning to make intelligent decisions based on several hierarchical concepts.

Example: Personalized Netflix recommendations

Speech Recognition

Speech processing or recognition allows a machine to recognize and interpret human speech. This technique makes it possible to translate words to text, similar to a transcriber. It can also translate simple commands from humans to actions understood and performed by machines.

Example: Apple's Siri calling a contact by voice demand

Natural Language Processing

Natural language processing is a more sophisticated type of speech recognition. By using deep-learning technology, it has the ability to determine the intent of the spoken words. This unlocks the possibility to have dialogues with machines hard to distinguish as artificial.

Example: Personalized auto-complete function in WhatsApp

Image processing

Image processing is using algorithms to enhancing, restore, compress or analyze an image, allowing to extract more information from an image.

Example: Google translating text directly with your phone's camera

Computer vision

Computer vision 'understands' the meaning of an image. This allows machines to process images and recognize the information presented by its visual features.

Example: Facebook detecting and censoring prohibited pictures

In Japan the AI field is not dominated by just one type of actor, but exists of a collaboration of actors in the public, private and research domains. This chapter will elaborate on the most prominent actors in the AI field and how they relate to each other. The actors are divided among three groups: the private sector, public sector and research facilities. These three groups are intertwined with each other and the distinction between the groups made in this chapter is schematic. It must therefore be noted that this division between three types of actors is a simplification of the actual situation. Only the most prominent connections are shown here. It does not exclude the possibility of, for example, a Japanese university provided with funds from the automotive sector within the AI domain, even when it is not shown in the figure below. The reality of the wide application field of AI combined with complex intertwined relations among the actors, demands a simplification to be comprehensible.
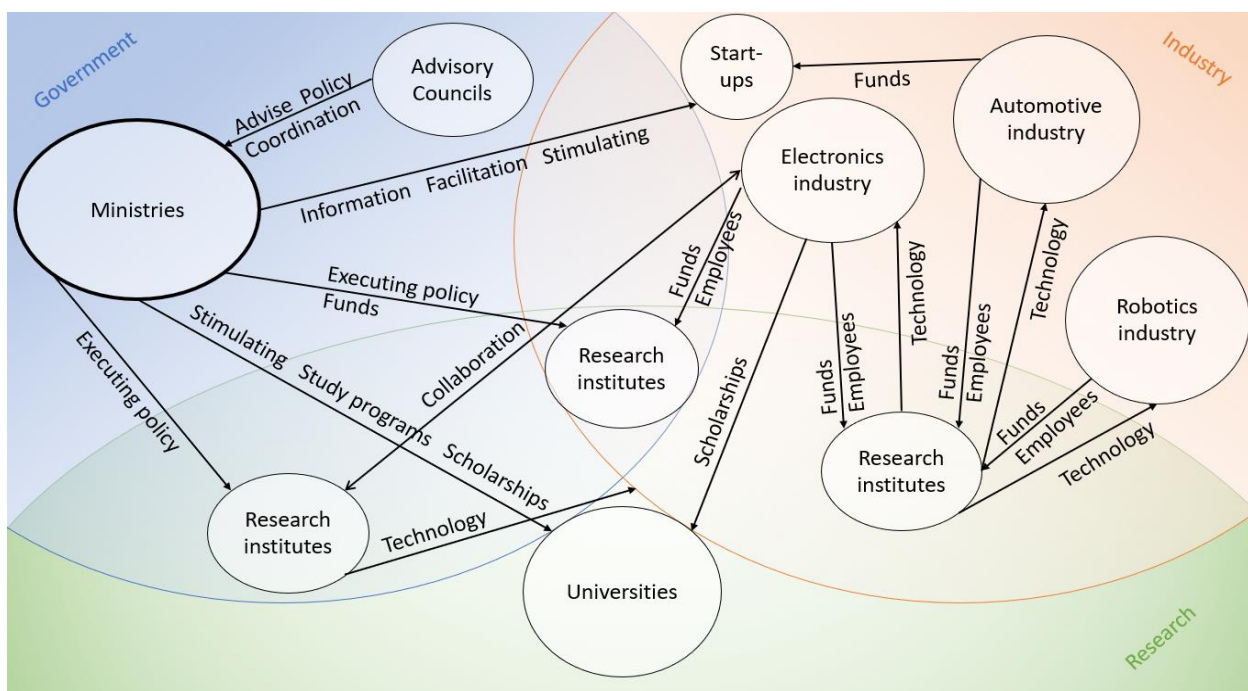

Figure 1: Actor analysis

Japan is especially well developed in AI-related technology in the automotive, robotic and electronic domains, hence highlighting these industries in the figure above. This overview is a summarized view of the relations between actors. In the rest of this chapter we will dive into the connections from the different type of actors' perspectives and their (individual) relations to AI technology. First, the actors in the public sector will be described followed by the research institutions. Since there has been an in-depth analysis for the public and private sector, the research institutions related to these have automatically been described in the actor analysis of the public sector and, where appropriate, mentioned in the private sector as well. Therefore, the research institutions do not have a separate in-depth analysis with a figure of the research actors, as it would not contain additional information. It does however have a description of the main actors and their specializations. Finally, this chapter will conclude with a closer look to the private sector, mainly focusing on the electronic, automotive and robotic sectors.

Within the Japanese government, AI is an important method for the future design of the nation, also known as Society 5.0. AI is part of the national agenda and financially supported in its development (Ishii, 2018). (More on the AI roadmap of the Japanese government in the next chapter.) An example of this is the research program PRISM, consisting of public and private R&D investments (Stronks, 2019) or the Moonshot program similar to Europe's Horizon2020 (Kuczynska, 2019). The Japanese government seems to give more often coordination or advise, opposed to funds, differing from the Netherlands. The figure bellow shows the different relationships between the actors, variating from funding /financially supporting, policy / coordination (mandatory guidance) or advise / informing (not mandatory guidance). The most prominent actors will be presented cursive in the text.
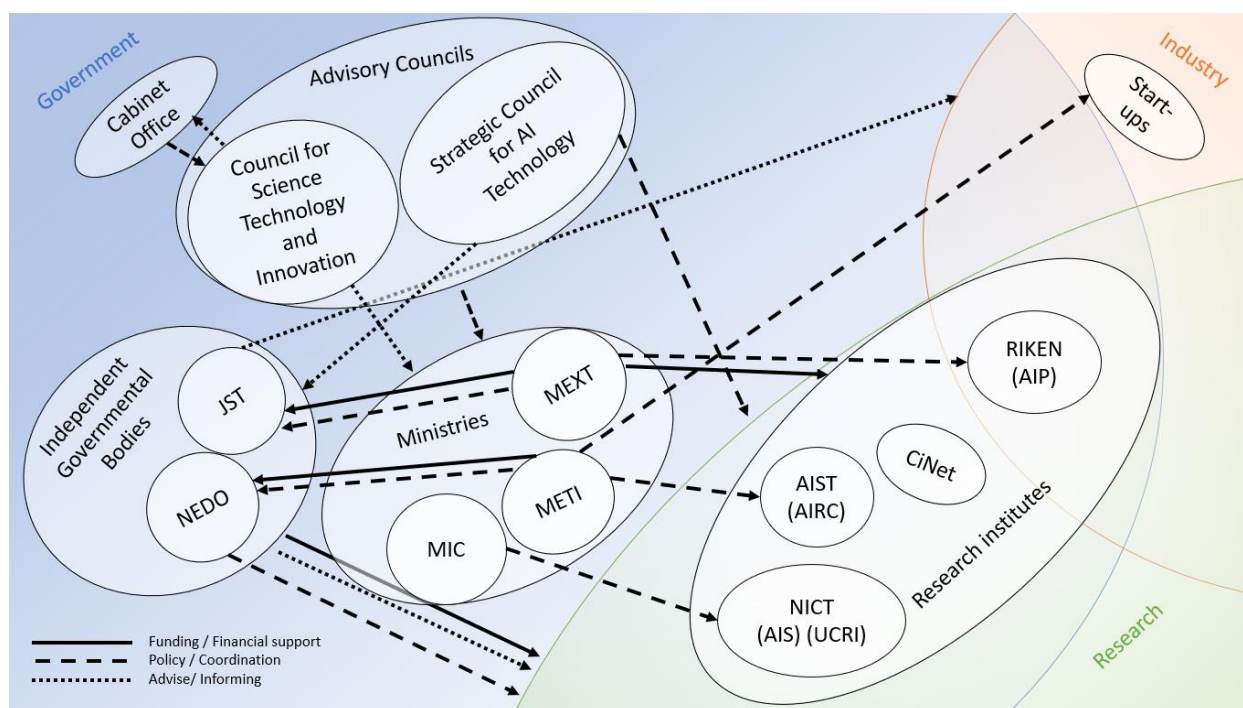

Figure 2 Actor analysis governmental institutions

The *Cabinet Office* has a coordinative role regarding strategic matters under supervision of the Cabinet Secretariats highest official, the Chief Information Officer (CIO) (Ishii, 2020). The coordination of efforts and information exchange is the responsibility of the Council for Science, Technology and Innovation (*CSTI*) (Kuczynska, 2019). Under the leadership of the Prime Minister and the Minister of State for Science and Technology Policy, CSTI overlooks all of the nation's science and technology, advises and formulates policies (Cabinet Office, n.d). The execution of the AI strategy is divided over three ministries: The Ministry of Internal Affairs and Communication (*MIC*), the Ministry of Economy, Trade and Industry (*METI*) and the Ministry of Education, Culture, Sports, Science and Technology (*MEXT*). MIC is in charge of the societal impact and governmental necessities regarding AI. It is especially focused on supporting R&D. METI is tasked with the position of AI in the

private sector and supports related start-ups. Finally, MEXT is in charge of educational and research aspects, promoting research as well as new study programs and other actions to challenge the human resource shortage (European Union, 2019).

The Strategic Council for AI Technology (*SCAIT*) acts as a control tower between the ministries and manages five national research and development agencies and three research centers (SCAIT, 2017). Finally, two independent governmental agencies relevant as well: the Japan Science and Technology Agency (*JST*) and the New Energy and Industrial Technology Development Organization (*NEDO*). JST targets technological developments on the governmental agenda and funds basic research, supports the commercialization of new technologies, distributes information on science and technology and promotes international joint research and human resources (JST, 2020). NEDO funds technology development and coordinates technological capabilities and research abilities of industry, academia and the government. It also promotes development of innovation and high-risk technologies and has several international offices (NEDO, 2020).

RESEARCH INSTITUTES

AI is booming and therefore research facilities, universities and school programs are increasingly supported with funds, staff and programs by the public and private sector. The three most prominent research facilities are; AIRC, based at AIST and funded by METI; the AIP Center based at RIKEN and funded by MEXT; and AIS based at NICT and funded by MIC (Ishii, 2018). The reason for these differences in ministerial support can be found in the focus of the centers.

AIRC is focused on AI in the private sector (Kuczynska, 2019). It concerns itself with AI in mobility, healthcare, productivity, and infrastructure. AIRC also collaborates with universities in Germany, France and the UK.

AIP is specialized in generic technologies and AI in society. It has partnerships with several EU institutes and collaborates with the private sector through the coalition of NEC, Toshiba and Fujitsu (European Union, 2019).

Finally, *AIS* looks at brain architecture, neuro computing and data knowledge integration. The focus is on communication, for example natural language processing, multilingual translation and multilingual speech processing (Kuczynska, 2019).

WWII through Image Processing

18-year-old Niwata works together with the University of Tokyo to colorize photos using AI. With the 75th anniversary of WWII's end, this project hopes to spark happy memories from before the war by the rapidly aging generation. AI can recognize and color natural elements and color them automatically. Human made objects like clothes are still to difficult to automatically color correctly for the AI technology used.
(Japanese Times, 2020)

Student startup for AI inspections

Students form the National Institute of Technology work together with the University of Tokyo and started a venture company for AI inspection systems targeting overhead power lines. The system analyzes footage of powerlines, detecting damage human eyes cannot see.
(Shikoku Shimbun, 2020)

While these three centers are expected to be main links between universities, industry and international organizations, there is also an increasing number of independent AI research facilities with numerous collaborations. Looking at the publications, Japan is prominently represented in the field of computer vision, robotics, speech processing and control methods. Especially AIST and NICT can pride themselves in their developments in machine learning, computer vision, speech processing and natural language programming. At university level, most universities offer a specialization or study program in AI, although the University of Tokyo is the most prominent. The Japanese government offers students and staff exchanges and scholarships. Their focus is on attracting human resources through exchange programs like Vulcanus (European Union, 2019). Finally, private sector has its own research centers and AI programs as well, as will be shown in the next paragraph.

PRIVATE SECTOR

The private sector has a major role in AI research and development. Prominent companies like Toshiba, Toyota, Fujitsu, Hitachi and NEC are invested in diverse practices and technologies of AI (European Union, 2019). The private sector is a vital part of AI R&D investments, with the automotive sector as the biggest contributor (Greimel, 2019). The ties of the private sector with research institutes and the government are thigh. In the AI research and development environment, the private sector plays a vital part in stimulating innovation, research and making the AI technology consumer friendly. It therefore plays also a major role in the Japanese developments of Society 5.0. To elaborate more on these connections, this chapter will show an in-depth actor analysis of Japans main industrial sectors related to AI: the electronics, automotive and robotics sectors. Of course, the relationships and examples presented in this paragraph do not include the numerous examples of initiatives in this rapid developing field.

Electronics sector

The first example of AI in the private sector can be found within the electronics industry through Rakuten. *Rakuten* is in the Japanese electronics sector an all-round actor in internet services and fintech. It has its own Rakuten Institute of Technology (RIT), which mainly focuses on advanced machine learning and deep learning and covers areas like IoT, network optimization, fraud detection, NLP, computer vision, virtual reality (Rakuten, 2020). Another example of collaboration between the private sector and research institutes within the electronics sector is the collaboration *Panasonic* and several Japanese universities, oversees universities (non-EU) and public research centers like NICT (Panasonic, 2020) and AIRC (AIRC, 2020). The nature of these collaborations is mainly focused on establishing AI research labs.

AI disinfecting smartphones

As electronic stores noticed an increase of infected staff members during the COVID-19 pandemic, Telecommunications firm KDDI launched an AI service for stores selling smartphone devices and comparable displayed items which customers are keen on touching. Through store cameras, AI can identify the smartphones at display and detect which surfaces are touched by customers. This technique collaborates with the robot's sectors. After the toughed areas are detected on screen, a robot makes a round through the store to disinfect the phones using ultraviolet light.
(NHK , 2020)

The third example of collaboration is the interesting fusion of Fujitsu, NEC and Toshiba with the Ministry of Education, Culture and Sports, Science and Technology (MEXT), establishing the *RIKEN* Center for Advanced Intelligence Project. The companies offer funding and employees to this institute (Stronks, 2019). Zooming in on Toshiba, Fujitsu and NEC individually, it becomes clear that their AI affiliations do not end with RIKEN.

Figure 3: Electronics sector

Toshiba has its own scholarships for student from Japan and several international universities from Europe (although none from the Netherlands) through the Toshiba International Foundation (Toshiba, 2020). Furthermore, there has been speculation of Toshiba opening its own scholarship specifically aimed at AI researchers with the University of Tokyo, although this has not been confirmed (Japan Today, 2019).

Fujitsu is specialized in big data. Its AI endeavors are bundled together in Zinrai, Fujitsu's Human Centric AI center with a focus on detection, recognition and machine learning. Fujitsu's ambitions spread outside the electronics sector, as it also wants to use AI in the robotics and automotive sector (Ishii, 2018). Fujitsu has a global partnership with Microsoft to accomplish this (Fujitsu, 2020).

Finally, *NEC* has put its AI endeavors in their IoT platform named NEC the WISE. This platform is aimed at businesses and AI makes it possible to collect and process data efficiently at high speed to create an online infrastructure for the businesses (NEC, 2020). Apart from this platform aimed at businesses, NEC has also developed AI applications for governmental institutions. Examples being a police fingerprint system and a facial recognition system for the Japanese immigration services (Ishii, 2018).

It becomes apparent that the electronic sector is intertwined with actors outside its own electronic bubble, collaborating with European universities and international players like Microsoft. This sector is highly interconnected among the AI application field, creating more than technology aimed as consumer products. The electronic sector invests in long term knowledge development and facilitates the governmental agenda, but is not unique in this approach. This is to a certain extent similar to the automotive sector.

Automotive sector

The actors within the automotive sector have a strong interconnectedness among each other and international endeavors similar to the electronics sector. An example is the strategic partnership of *Alliance Venture*, a collaboration of Mitsubishi Motors, Renault and Nissan, with its headquarter in Amsterdam. It pursues strategic investments at all maturity stages in startups developing disruptive technologies or businesses (Alliance Ventures, 2020).

However, the most prominent automotive actors in this story are Toyota, Honda and Nissan. To put the role of the automotive sector in perspective, this sector has occupied the top four slots for of overall R&D spending in Japan in 2019. Toyota being the biggest spender with a budget of €8.6 billion and the Toyota-affiliated Denso as the fourth highest with €4.1 billion. Toyota was followed by Honda with €6.7 billion and Nissan with €4,3 billion (Greimel, 2019). For AI specific, the investments of Toyota, Nissan and Honda are mostly directed at the development of self-driving cars.

For *Toyota* the necessary AI technology for self-driving cars, deep learning of facial, behavioral and speech recognition, is being developed in the Toyota Research Institute (TRI). *Honda* cooperates with the Chinese SenseTime company that specializes in deep

> **Toyota Woven City**
>
> *"Imagine, a fully controlled site that would allow researchers, engineers and scientists the opportunity to freely test technology, such as autonomy, mobility, robotics, smart home connected technology, AI, and more, in a real-world environment.* (…) *We thought, why not build a real city, and have real people live in it, and safely test all kinds of technology? (…) This would be a truly unique opportunity to create an entire community, or "city," from the ground up and allow us to build an infrastructure of the future that is connected (…) It would be a chance to collaborate with other business partners and to invite all interested scientists and researchers from around the world."*
> ~ Akio Toyoda,
> President of Toyota Motor Cooperation
>
> (Toyota, 2020)

learning and image recognition. Honda is not only active in the automotive sector, but also in the robotics sector as it also uses its AI endeavors on general physical mobility (Honda, 2020). Finally, researchers from *Nissan* cooperate with NASA to develop AI technology, sensors, and software to build a self-driving robot car (Ishii, 2018). Nissan uses robotic technology from NASA to improve its product and, like to Honda, is also intertwined with the robotics sector, although in this case the robotic technology is not from Japanese origin.
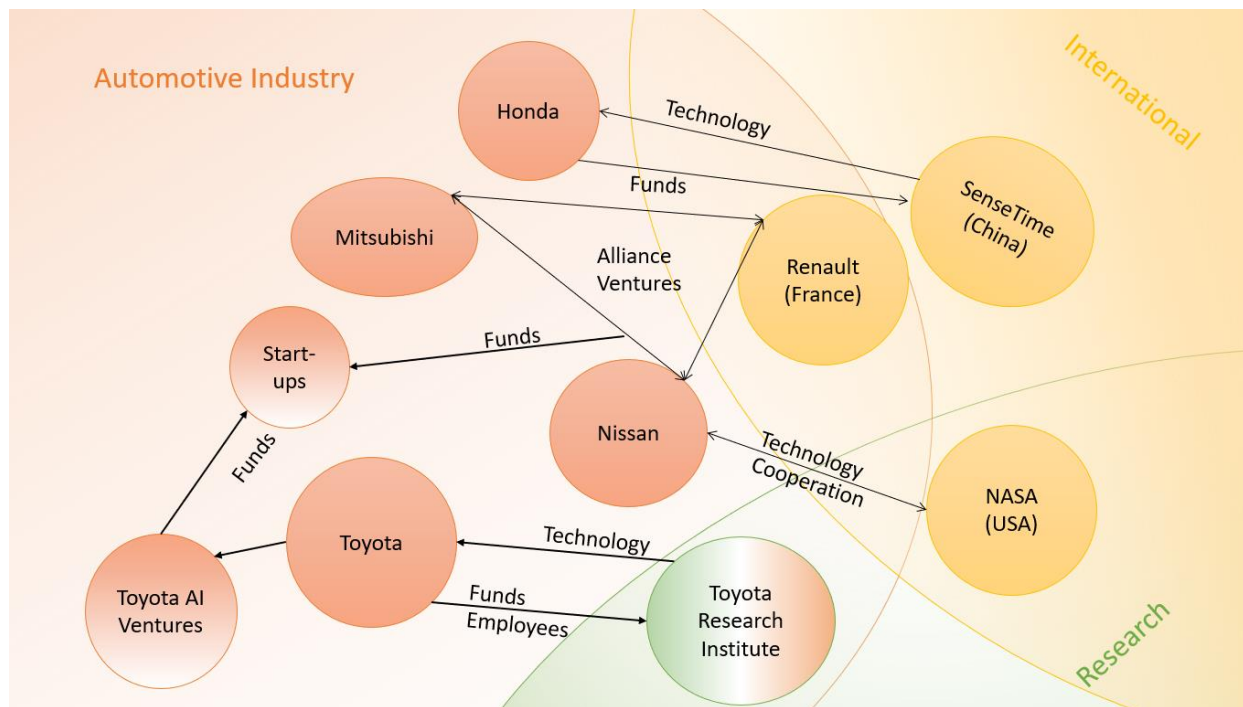
Figure 4: Automotive sector

Robotics sector

The actors within the Japanese robotics sector seems to be more nationally focused compared to the previous sectors, but have big interdisciplinary players. Our first example of AI in the robotics sector is *Mitsubishi Electric*'s Maisart research program. This program focusses on developing and researching deep-learning, reinforcement learning and big data analysis (Mitsubishi Electric, 2020). A practical application would be in industrial robots, where AI technology can distinguish abnormalities and detect signs of machinery failure prior to actual breakdowns (Mitsubishi Electric, 2019).

Secondly, *Hitachi* is, similar to Mitsubishi Electric, a broadly oriented company with ties to the automotive, electronics and robotics sector. Hitachi sees robotics as the bridge between the virtual world and the consumers. It uses AI to create robots that can navigate, communicate and interact with its surroundings (Hitachi, 2020). Another actor in the robotics sector is *FANUC*. FANUC specializes in industrial robots and factory automation. It uses AI machine learning to train robots in an easier manner. Hitachi and FANUC joined hands with Preferred Networks to establish a joint venture: Intelligent Edge Systems (IES). IES utilizes AI as an intermediary between the cloud and robotics to achieve cyclic real-time control. IES has stated to be committed to the realization of a human-centered Society 5.0 (Preferred Networks, 2018). On the topic of robotics AI partnerships, another partnership can be found between Yaskawa Electric Corporation and XCompass in the form of a new company named *AI Cube*. AI Cube develops AI technology for manufacturing and industrial robots as well (Yaskawa, 2018).
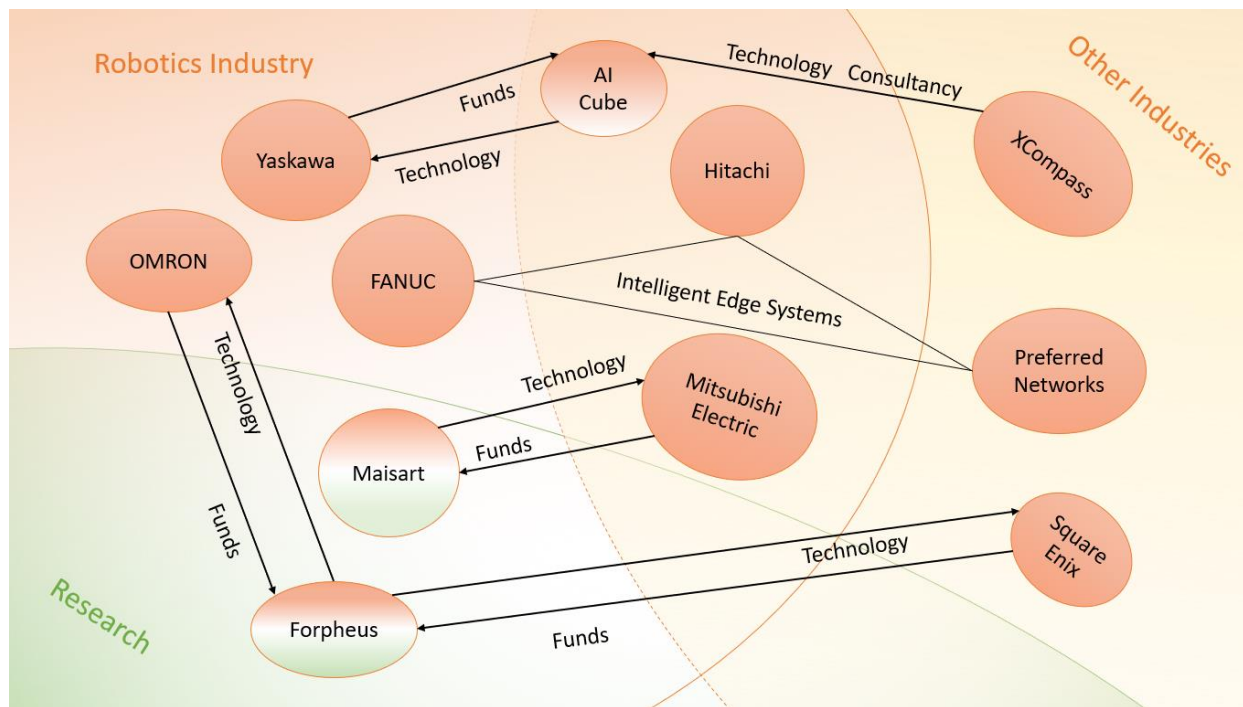
Figure 5: Robotics sector

A final example of AI robotics collaboration can be found in *OMRON*'s creation of the table tennis robot Forpheus, combining robotics with AI and the gaming industry. OMRON is specialized in industrial automation and electronic components. For this project OMRON joined hands with Square Enix, a famous Japanese gaming company with well-known titles like Final Fantasy (OMRON, 2020). The goal of their combined research is to develop an AI algorithm that generates motivational feedback to bring out the ability of human growth, also known as serious gaming. OMRON provides AI technology that can read human emotions. Square Enix AI technology can analyze (emotional) responses from users and predict the game's unfolding. Both have different motivations for this project. Square Enix wants to create a way of playing in the in the real world without the need of a display screen and OMRON wants to develop future factory automation, healthcare and social solutions. However, both believe in the establishment of a new relationship between humans and machines, in which the machine can optimize human performance. With this shared vision of AI being used for optimizing human performances, well fitted in the Japanese AI strategy which will be explained in the next chapter, this actor environment overview is concluded. While the next chapter will not go in-depth into individual actors, it will become clear why we see an increase in start-ups and (cross sectoral) collaborations in Japan.

THE JAPANESE AI MARKET

AI-driven technologies are the next step in the technological revolution, some would even describe it as the next disruption in enterprise technology (OSA DC, 2018). But what does this mean for the market? This chapter will describe AI in a global perspective and its forecasts for Japan. This chapter contains multiple sources of market analysis of which all project growth of the future AI market. However, it must be noted that this report is being written during the COVID-19 pandemic. Meaning that the projections up until now have been estimations based on data gathered before COVID-19's impact on the world's economy. This chapter will therefore also discuss the potential of AI in a post-COVID-19's world. Finally, a PESTL and SWOT analysis will be added to gain a complete overview of the inhibitors, drivers, strength, weakness, opportunity and threat of AI in Japan.

AI ON A GLOBAL LEVEL

While the exact projections of AI revenue differ among sources, all agree: AI will be booming. The global AI market estimated compound annual growth rate (CAGR) between 2018 to 2025 differs from 33% to 55%. By 2025 the AI global market is projected to be worth between 156 and 360 billion euro's[2]. Although it must be noted that the projections do not make statements directing towards this increase of market value to be linear.
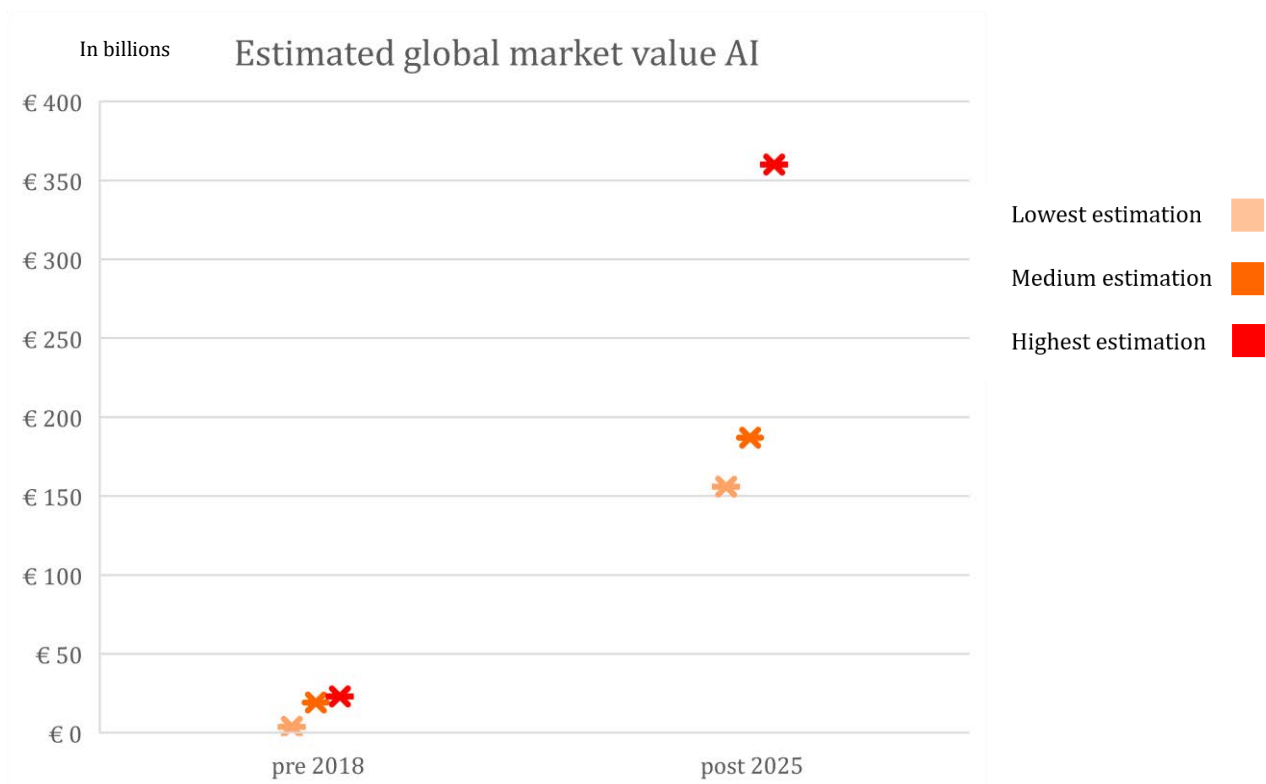
Figure 6: Estimated global market value AI

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[2] Based on projections from AMR, GVR and Fortune Business Insights. Dataset included in figure.

On a global scale North America has held the dominant share in the AI market. As one of the early adopters, North America adopted the AI developments in a faster pace than most regions. However, the Asia Pacific region is anticipated to overtake North America's number one spot on the global AI market by 2025 (GVR, 2020). Several sources have estimated the Asia Pacific region to have the highest compound annual growth rate in the AI field, projecting a CAGR up to 59,4% from 2019 to 2025 (AMR, 2020)in the most aggressive case.

AI helps business recovery

The Japanese Odajima invented an app that predicts a restaurant's customers amount through AI with 95% accuracy. Odajima says AI-based management can raise sales per customer significantly and help restaurant holders to calculate business survival methods during the pandemic (Tsukimori, 2020).

In addition to the increased market share of AI, the different AI technology fields have increase and changed in importance as well. AI software in 2020 is estimated to grow 154% annually with a market value of 21 billion EUR (Shanghong, 2020). As of the past years, natural language processing has been the number one adopted AI technology on a global scale (Fortune Business Insights, 2020). However, it is projected that machine learning will gain a more prominent role by 2025 (GVR, 2020). As part of the machine learning technology, deep-learning is expected to increase from a 186 million EUR in 2015 to a 10.2 billion EUR in 2024 (OSA DC, 2018) An increase in natural language processing, image processing and speech recognition is expected as well, although not with such a rapid increase of revenue as machine learning. Another projection is the rise in demand for AI in healthcare, automotive and AI powered industrial robots. AI revenues in the healthcare sector and automotive industry, mainly in self-driving cars, can be expected to increase with several billions (GVR, 2020) (OSA DC, 2018).Industrial robotics, a source of pride, gets an ever more prominent place, as Japan´s manufacturers deliver 52 percent of the global supply (IFR, 2020).

AI MARKET IN JAPAN

Japan has at the moment 200 to 300 AI-related companies (Data Artist, 2020). Japan is number one in the world as a supplier of industrial robots and third, after China and the USA, in AI R&D (OSA DC, 2018). Zooming in on Japanese companies AI patents, Toshiba is Japans champion and the world's third, after IBM and Microsoft.
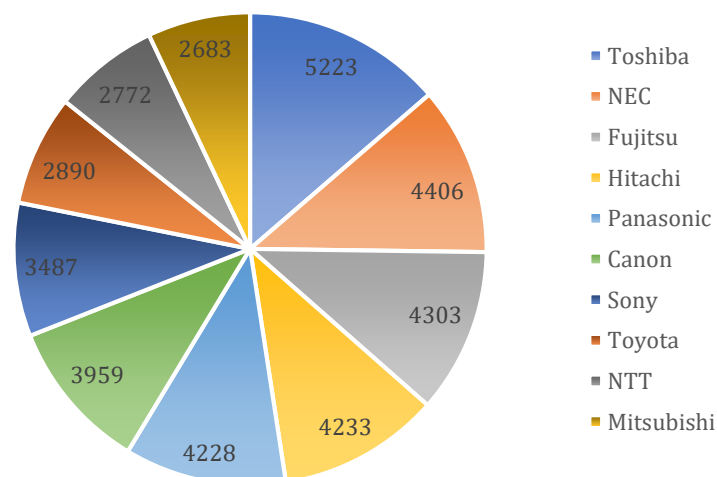

Figure 7: Top ten Japanese companies for AI Patent families (European Union, 2019)

Research results from METI show a rapid rise in domestic patent applications for AI-related inventions as well. Their latest numbers show a 54% increase in 2018 compared to 2017, identifying it as the 'third AI boom'. In most of the inventions machine learning is used as the main technology, referring increasingly to deep-learning over the past years. Figure 8 shows the most patented AI applications in Japan (METI, 2020).
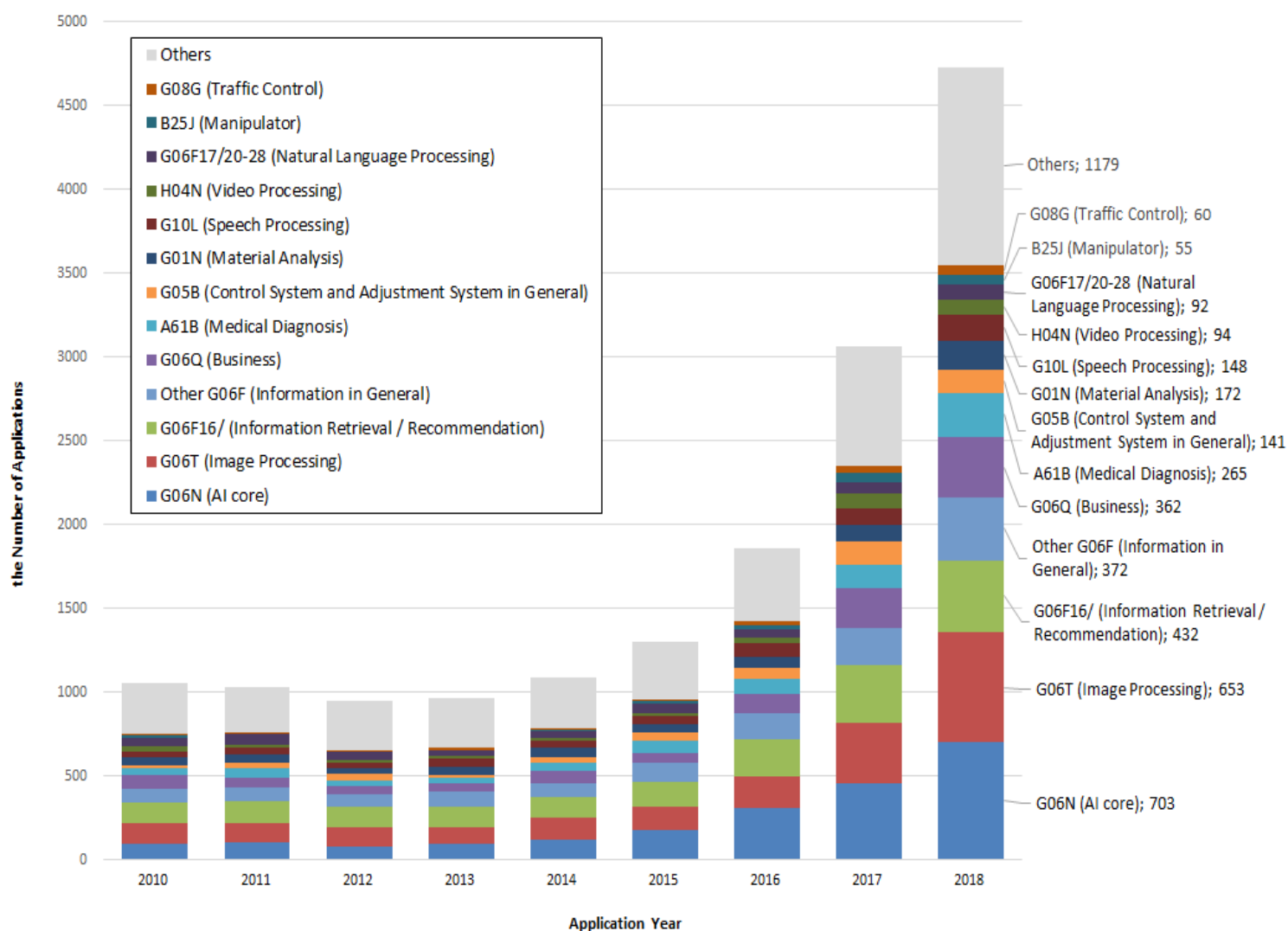

Figure 8: From METI report: Changes in the fields to which AI-related inventions are applied (METI, 2020)

In the future, Japan`s position within the AI market is estimated to grow up to 0,7 to 0,75 billion EUR by 2030 (Graci, 2020) (OSA DC, 2018) and expected to gain an economic return of 1,1 billion EUR by 2045 by the Japanese government. As will be described in the next paragraph, one of the focus areas for Japan is mobility, which is expected to increase a lot. This is reflected by the growth in the transport sector, expected to increase the most with 0,26 billion EUR and the growth of 0,10 billion EUR in the manufacturing sector, which also includes self-driving cars (OSA DC, 2018).

Japan aims to stay a prominent player in the high-tech sector with AI as one of the vital components, not just for the sake of being a leading nation in this world changing technology. Japan wants to utilize AI in its policies to address its own societal issues, to have sovereignty over its fate and to actively design its own future. Therefore, the Japanese AI strategy is a key part of the transition to their envisioned Society 5.0 (Cabinet Office, 2020). Society 5.0 stands at the core of several research programs, like the Japanese Moonshot program, similar to Europe's Horizon2020, and the cross-ministerial Strategic Innovation Promotion Program (SIP) (Cabinet Office, 2020) (Cabinet Office, 2019). While AI plays a supportive role in many developments within the Society 5.0 vision and related programs, SCAIT has also developed a strategy especially for AI developments and a roadmap as how and where to implement its different applications. This paragraph will explain the AI strategy and introduce Japan`s main ambitions.

So how is the AI development visualized? The Japanese government has estimated several priority areas [3] as part of the roadmap for AI integration in society and industry (see figure 7). The first area is *productivity*, with a focus on the enhancement of creativity and innovative services. User-driven hyper customization by automation and enhancement of production and services, distributes goods and services consistent with the needs of citizens. One clear future end goal is the utilization of robots that are autonomously able to predict and produce 'just in time' and 'on demand', resulting in a zero-waste society. The second priority area is *health, medical care and welfare*. Japan aims to be the leader in medical care and welfare technologies by utilizing big data and AI. This goal comes from the urgent need to respond to its rapid aging society. This part of the strategy is very active in prevention and monitoring of diseases. In the future, Japan wants to provide the possibility to design our own body and to replace body functions by artificial organs and sensors. Further, robots will function like family members, being part of our daily lives, caring for us and our day to day tasks. Finally, *mobility* is the third focus point, with the aim for everyone and anything to be able to travel freely, safely and environmentally friendly. From decreasing the human factor in accidents by autonomous transportation or minimizing the need of transportation altogether, mobility will change with AI. SCAIT foresees a future where the cyber and physical space are fused, with examples as virtual tourism and virtual office spaces (SCAIT, 2017).

While these ambitions seem quite futuristic, this aforementioned strategy and the examples are not. SCAIT introduced a roadmap with three phases how AI technology is expected to integrate in society. The *first phase* is the growth of utilization and application of data-driven AI along the needs of the service industries. We are currently gradually transitioning from the first phase into the second phase. The phases do not have the same starting point for all AI-related industries, and the transition takes place with different paces. The *second phase* is about the public use of AI and data. The roadmap considers some other, unanticipated use to become relevant as well. The *third phase*, is expected to arrive between 2025 -2030. In this phase, multiple domains get connected and transition into a cross-domain ecosystem.

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[3] These priority areas are part of the Industrialization Roadmap. In addition to the three areas, a fourth area "information security" was mentioned as a cross-sectional area, but not established as a roadmap target.
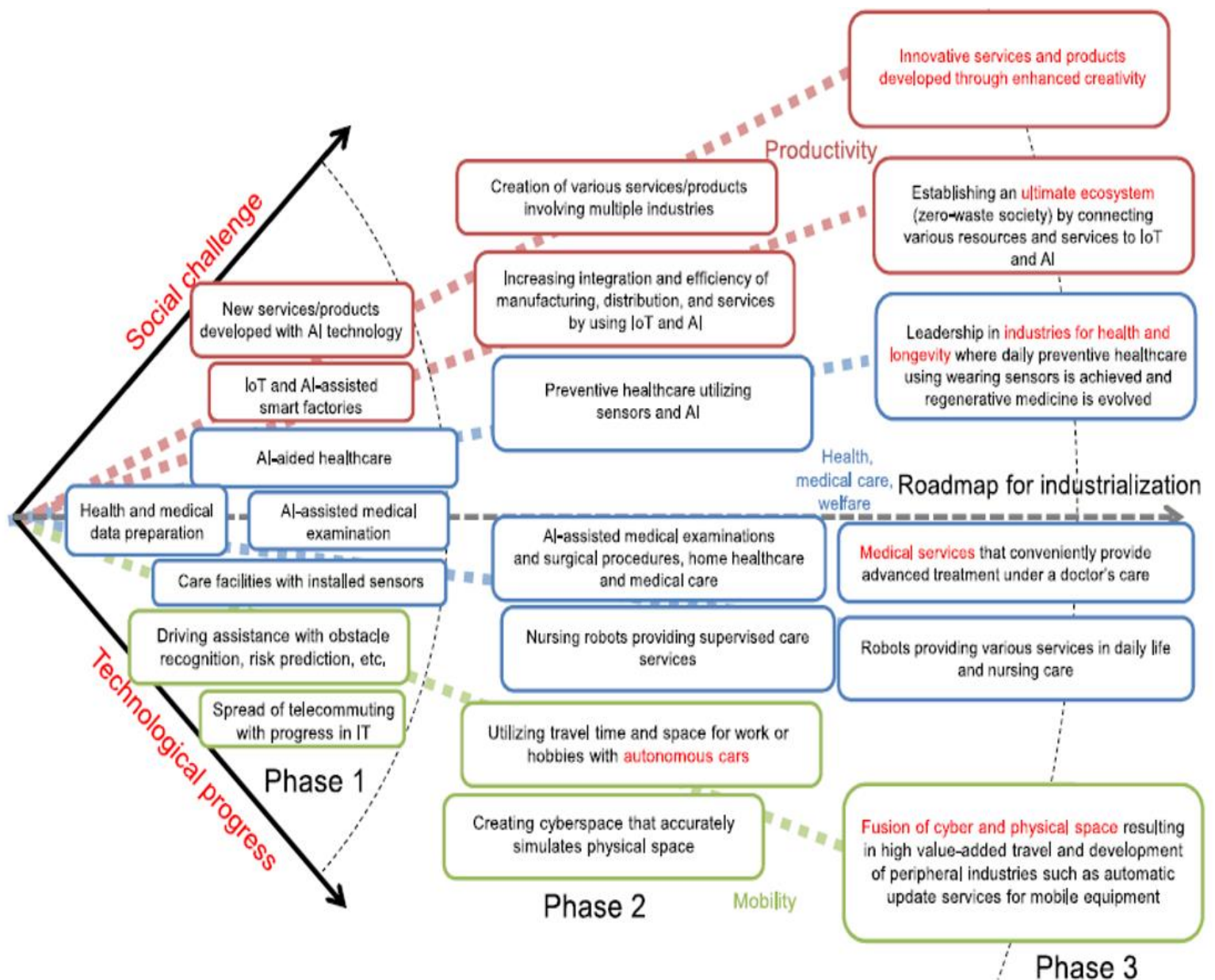
Figure 9: Fusion of AI and other Related Technologies (SCAIT, 2017, p. 4)

The AI strategy and roadmap has been written taken changes in technology and societal preferences into account. However, what could not have been predicted was the devasting effect COVID-19. The fallout of the virus has impacted our lives broadly and the timing of the neatly planned phases of the AI implementation. Furthermore, the implementation of AI is also more than a market analysis of intellectual property and economic returns. AI has a potential impact on many aspects of society. The next chapter will therefore provide an in-depth look in the opportunities and threats for AI and dive into the macro-level trends of the Japanese AI market from several perspective, which includes the (anticipated) effects of the COVID-19 virus as well.

REINVENTING JAPAN THROUGH AI

AI has a potential impact on many aspects of society. The impact however, has not always been for the worst. Technological developments can thrive during chaotic times and this crisis is no different. AI developments have not come to a complete standstill until economy recovers. This chapter looks at macro level trends, which have an effect on the development of AI in Japan by using five different perspective; the political, economical, societal, technological and legal dimensions, or in short PESTL. Looking through these five glasses, this rapport describes the present Japanese situation and also includes the current uncertainties surrounding COVID-19.

DEVELOPMENTS IN JAPAN ARE FAVORABLE FOR AI

Political	Economic	Society	Technological	Legal
•Self-sufficiency	•Economy	•Medicare demand	•Security	•Data storage
•Society 5.0	• Automation	•Robot friendly	•Software	•Legal framework
	•Talent shortage	•Consumer comfort	•Robotization	
		•Remote services		

COVID-19 positive effect on AI development
COVID-19 negetive effect on AI development
COVID-19 no effect on AI development

Figure 10: Major inhibitors and drivers of the development of AI in Japan

POLITICAL

- **Self-sufficiency:** Due to the geographical location and the strained relationships with its neighbors, Japan aims to be self-sufficient in many dimensions. This includes technology, as having the latest technological developments through own inventions means having more insight in the specifics of the technology. This is reflected in policies to become a frontrunner in several AI domains and investments in the many recently established AI knowledge centers. As the pandemic has shown that international supply-chains can be frail, it is expected that this desire for self-sufficiency of the island nation will increase even more.
- **Society 5.0**: AI is of strategic importance for the Japanese government as a core technology of the vision of Society 5.0, and with that, the 5th Science and Technology Basic Plan and the Annual Growth Strategy (European Union, 2019). Developing cross sector services and policies able to adequately accommodate Japans future, Japan wants to lead in practical applications of AI. This vision for the future influences the direction of AI related policies and supports investments in AI related project. This future vision heavily relying on digitalization, of which AI, as one of the key digital technologies, can be seen as the backbone, and is expected to become increasingly relevant due to the pandemic. Moreover, the Japanese government has decided to allocate finances to support R&D, including AI, even more during these difficult times.

- **Economy:** At the moment Japan experiences an economic downturn. Many sectors are suffering due to the pandemic and have generally fewer financial means to invest. Although digital services were less impacted compared to tourist sector or the automotive industry. This economic crisis creates incentives to continue AI developments, but that unfortunately does not help on the short-term.

- **Automation**: The Japanese workforce is shrinking due to an aging population and a low birthrate (Gloture, 2019). Manual labor is gradually being replaced by robotization and automatization. Robots will become increasingly capable of doing complex and physically demanding tasks due to advancement of AI, which is making the aging less problematic. During the pandemic this robotization of tasks has gotten an extra incentive due to safety constrains, as social distance has to be maintained.

> **Tourism meets AI**
>
> COVID-19 put a halt to the Tokyo 2020 Olympic Games, international tourism and it lowered domestic tourism dramatically. The Japanese company Ebilab has developed a service for the city of Ise, providing a virtual reality tour which takes tourists on virtual excursions to the Ise shrine. To make the virtual holiday complete, you can virtually shop at Ise's souvenir store and interact with employees by web camera.
> (Tsukimori, 2020)

- **Talent shortage:** METI foresees a shortage of 120.000 AI business experts by 2030. To tackle this problem, the government aims to attract 250.000 AI experts from abroad by internationalization of education programs and by making foreign exchanges more attractive with funds and special working visas (Gloture, 2019). English as a working language is stimulated and appointing foreign researchers in management positions is encouraged as well (European Union, 2019). Japan is also in the process changing their education system (OECD, 2018). Japan is not the only nation facing an AI talent shortage, so is the Netherlands among many others (Ministerie van Economische Zaken en Klimaat, 2019). This problem will be hard to solve soon by attracting foreign expert alone, while the effects of educational reforms can only be harvest in the future, if anything, COVID-19 made the immigration process more difficult.

SOCIETY

- **Medicare:** Japan's elderly population will exceed the 40% in 2030. Because of the predicted increasing demand of medical support, Japan has set a goal to become the leader in medical care, health, welfare and longevity by combining medical advancements. During the COVID-

The aforementioned stacking robot of convenient stores resembles, according to its makers, a kangaroo. The earlier model was a humanoid model, but made the customers uneasy. This model makes customers feel more at ease.

CNN 2020

19 pandemic the value of AI in several medical fields became clear once again; from analyzing huge amount of data to determine a feasible vaccine to remote care. This trend was already in place before the pandemic, but is expected to have been boosted due to the situation even more. This increased need of AI backed medical equipment is supported in several programs and packages from the Japanese government, paving the way for the needed digital infrastructure. One example of this is the SIP 'AI Hospital System', building a high-security database system (Cabinet Office, 2019).

- **Robot friendly**: The adaptation of AI in daily routines is relatively well accepted in Japan. Whereas in Europe there are some sceptic and sometimes frightening visions of a future interwoven with AI, the consumer market of Japan is highly enthusiastic. Especially in regards to AI driven robots that can resemble human behavior. These are often presented as happily co-existing with humankind by popular media, portraying cute (or kawaii) robots like Doraemon rather than the Terminator. This aids to the societal acceptation of robots and AI development in the services (Gloture, 2019). COVID-19 is not expected to have significant influence on this trend.

- **Consumer demands:** While a lot of AI applications discussed are targeted to solve societal problems, the AI technology developed can also be used to make the lives of the consumers easier. For example, AI technology originally used for virtually office meetings and translation services, have now been adopted by the average consumers, especially during the pandemic. As Japanese citizens seem to take less (public) issue with the collection of personal information to be analyzed and used in the machine learning process, AI driven services can quicker develop and adapt to the consumers need (Gloture, 2019).

- **Remote and online services:** Although some of the previous concepts have touched this subject somewhat already, it must be noted that the social distancing society we live in today has impacted services. Services like online shopping and online meetings are backed by AI technology and increasingly used during the pandemic. The bulk of consumer data produced by this is only aiding the AI technological developments. Be it in the production, medical or mobility roadmap, AI is expected to become more and more integrated in services. Many services traditionally physically performed, will become remote controlled through AI or done by AI robots, as is planned in the AI strategy (SCAIT, 2017). To put it into perspective; the potential impact of AI is estimated to replace half of the labor force in Japan by AI, remote controlled services and robots in the next 10 to 20 years (Lundin & Eriksson, 2016).

TECHNOLOGICAL

- **Security:** Due to the digital revolution, relatively new security threats have become reality. With AI technology, anomalies in access or usage patterns can be detected, but also irregularities in data patterns, which for example can be used to audit accounting. This trend seems to be mostly determined by the universal digitalization movement.

- **Software:** The earlier described trend of automatization as spurred software developments and AI. Modern products are increasingly relaying more on software updates than hardware replacements. That is also the case in Japan that tends to lean more towards hardware development than software.
- **Robotization**: Japans strategy towards robotization capitalizes its advanced industrial and functional robots' skills to create 'the most advanced robotics society'. This should also result in Japan as an innovation hub (Kuczynska, 2019). Robots are expected to become increasingly part of our day to day activities. During the COVID-19 pandemic it can indeed be noted that Japan is showing more examples of robotic solutions compared to a more app-oriented approach as we do in Europe.

LEGAL

- **Data storage**: The Japanese government is in the process of facilitating data sharing platforms and is creating a legal framework to accommodate this desire. Japan introduced a set of guidelines regulating the circulation of data use in public and private domains (European Union, 2019). One example that relates to the health, medical care and welfare, is the 'AI Hospital System' program under the SIP. This program aims to develop a high-security database system, supporting multiple languages and ensuring data confidentiality, aiming to have this data widely available and improve medical practice (Cabinet Office, 2019). AI's intelligence improves with the amount of data. This example paves the way for AI assisted auto recording, documentation and AI-assisted diagnosis.

> **Ending the Hanko era**
>
> The Japanese Hanko is a small circular red seal similar to a signature and needed on official forms. Because of the need to manually certifying official applications with a company seal, not all employees can telework. During the pandemic legal restrictions on electronic signatures became more relaxed.
> (Nippon, 2020)

- **Legal framework**: Like most countries, the Japanese legal framework is in need of an update to take the newest digital developments into account. This means that it is uncertain which developments are allowed in future. For example, AI uses big amounts of data to optimize its performance. If there are less limitations for data sharing, AI has the chance to develop faster compared to a situation that has a limited permission to use, for example, consumers data (OSA DC, 2018). Japan seems to have a similar approach regarding legal and ethical matters as the European Union regarding AI. The EU and Japan signed a joint statement to promote a human-centric approach[4] to AI (European Council, 2019), Japan is a loyal supporter of the Data Free Flow with Trust (Okano-Heijmans, 2020) and Japan finalized the Social Principles of Human-Centric AI in 2019 (European Union, 2019). COVID-19 increases the necessity of revisiting the laws in certain sectors. For example, official documents which normally needed to be signed in person are increasingly allowed to be digital, decreasing the amount of time and papers spent.

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[4] It must be noted that, though similar to the EU principles, the EU is more individual focus whereas Japan looks for an overarching societal vision

Based on the previous insights, it becomes clear that quite some changes at different levels during our lives are coming. The dawn of a hybrid human-technology based society seems almost in our grasp. Japan, while being traditionally internally orientated, is open for partnerships and cocreation to create this new advanced society. Looking at the growth of the AI market predictions, the time to invest seems to be opportune. All these findings point into the direction of a feasible window of opportunity for start-ups, researchers, investors or AI-based businesses. Depending on the specific skills needed, Japan could be an interesting partner to further your AI developments. For example, knowledge around software development and product enhancement is motived by the Japanese government and several industrial sectors. To become an interesting partner, it is necessary to understand the Japanese culture and invest time in building trusts and support a healthy collaboration between Dutch and Japanese initiatives.

This paragraph looks into the strengths and weaknesses of AI technology and development in Japan. It also addresses possible opportunities as well as possible threats for Dutch players in the AI field when considering to enter the Japanese market.

Figure 11: SWOT analysis Visibility

STRENGHTS

Japan has several strong suits, of which some of the most prominent will be highlighted here. Firstly, the Japanese government has a long-term vision for AI to solve several legislative, economic and societal issues. The Japanese government invest therefore a lot in R&D and AI. The Japanese AI strategy makes the path that Japan wants to take somewhat predicable and comprehensible for foreign parties to adapt to. Secondly, the private sector is very active in making Japan ready for the next phase. There is a strong tie between the public and private sector. One example of this is the multiple public-private co-created research facilities. The tight public-private relationship stimulates AI development form several perspectives and, as the actor analysis has shown, is especially reflected in the Japanese electronics sector. Looking closer at the AI developments, Japan excels particularly in computer vision, machine learning, speech processing, natural language processing, transportation and telecommunication. The increasing global demand for AI, especially related to robotics, speech recognition and visual recognition, is expected to boost the Japanese AI market.

> **Sushi meets AI**
>
> Due to the COVID-19 travel restrictions, fish merchants around the world have trouble visiting suppliers of tuna for quality checks. Fortunately, the Japanese Shimura invented a solution for an industry relying on local expertise: The Tuna Scope. A deep learning algorithm collects grading data from merchants and unified a grading standard to ensure high quality fish. The merchant's smartphone scans a tray of tuna and provides within a few seconds quality results, ensuring delicious sushi.
> (Kelly, 2020)

WEAKNESSES

Japans AI environment also has several weak points. First and foremost, the decreasing workforce puts a strain on Japans capability to provide enough skilled employees to keep up with AI developments on a worldwide scale. This lack of sufficient skilled domestic employees is not only related to the low birth rate, but has, alongside several other explanations, its roots in the education and corporate culture of Japan. Japan recognized that skills like flexibility, creativity and problem solving are needed to keep up with the fast-technologized societal developments and are therefore in the process of updating the education system (OECD, 2018). That being said, the workforce that will profit from this new system will not be accessible before 2030. At the moment these skills are generally not stimulated in the office either. The limitations of the skilled workforce are reflected in shortcomings in software developments as well. Whereas software is globally seen as the biggest share in AI, Japan has a hardware-centric focus. Software is getting increasingly more important to enhance (hardware) products and compete on the international market. As software is very closely entangled with AI, Japans hardware-centric reputation can be limiting in establishing future partnerships. Lastly, as Japanese publications and conference proceedings are relatively small, Japan's universities have seen a decline in its global AI position.

OPPORTUNITIES

Japan is increasingly looking for international partnerships and cooperation. The EU, and consequently the Netherlands, have the advantage to share similar social values for AI with Japan, which gives a mutual advantage in collaboration over cooperation with countries that do not share comparable human-centric values. Strategic initiatives like partnerships, mergers or collaborations can increase the competitive position of Japan and the Netherlands. Businesses are increasingly interested in enhancing products through software improvement rather than by creating new hardware products. Japans software limitations are perhaps a constrain in some partnership, but can be an opportunity to supplement with Dutch expertise or a complementary partnership as well. Another opportunity are scholarships provided by Japan for foreign exchange students to further broaden their knowledge. Which can stimulate partnerships between Dutch and Japanese universities. Especially deep-learning solutions have a great potential to grow, as this AI technology has not reached mainstream Japan yet. However, it becomes apparent this technology will be key for several important Japanese industries. For example, the automotive industry will be needing deep-learning solutions to develop their self-driving cars further. Dutch companies could look into a partnership related to deep-learning and applications in marketing, information and security. Last but not least, the smart solutions needed for the Japanese society in itself should be considered. Dutch businesses have the opportunity to promote their AI-related approaches in agriculture, digital health, elderly care, energy and financial services.

CHALLENGES

Jimae-shugi can be roughly translated to self-sufficiency or protectionism, in the sense that Japan prefers to use its own domestic developed technology and services, preferably to buy knowledge instead of co-producing. Although Japan is actively looking for partnerships, as a business partner it is wise to be aware of this principle going forward. Jimae-shugi might influence the knowledge exchange or related themes like services or personnel during the collaboration. Secondly, Dutch entrepreneurs need to be aware that it will take effort to establish a relationship with your Japanese counterparts. It is key to take ample time and attention to build trust in person before you are allowed to enter the partnership. Be aware that English is not as widespread compared to the Netherlands, likewise is the Japanese language not one many Europeans possess. While new technology, in which AI happens to play a major part, is partly resolving the language barrier, translating machines are not capable to interpret cultural sensitivities (yet). An additional challenge is the legislation for privacy and AI implementation, which is still in development. This may cause challenges for companies, as it can be difficult to know the direction of upcoming regulations. The Japanese government and businesses have to collaborate, which could aspire delays. Last but not least, Europe is not the frontrunner on AI. While it is important that we share similar values, Japan might look more at the USA and China for the latest AI developments. It is important for the Netherlands to work on their visibility related to AI specific skills and work on branding.

AI POST COVID-19

While the former chapters provided a general overview of AI in Japan, it is impossible not to pay special attention to the impact of COVID-19 on the current situation. The COVID-19 pandemic leaves a devastating trail through social life and economies all across the world. The pandemics' impact is accompanied by insecurity about the persistence of the virus. In the current most optimistic pandemic scenario, an effective vaccine will take at least a year to be widely available (OECD, 2020). In other words, we need to adapt to a new reality for at least a year or longer. This last chapter of the report dives into the effect of the COVID-19 virus on AI, its negative impact, its stimulating impact and the provided solutions for the new-normal through AI.

Our new reality has affected the Japanese R&D strategy as well, demanding a response from Japan and resulted in several useful Japanese AI applications, demonstrating their worth during the pandemic. As mentioned before, the Japanese AI strategy consist of three priority areas which together make the roadmap for AI integration in society. The first is *productivity*, focusing on an AI-integrated supply chain, predicting and matching the needs of consumers. The second priority area is *health, medical care and welfare*. One of its goals is to enable designing your own body, replacing body functions by artificial organs and sensors. The third area is the integration of AI in *mobility*, which would enable everyone and anything to travel freely, safely and environmentally friendly in the physical and virtual space (SCAIT, 2017). AI provided several useful applications to help in the global fight against COVID-19, investments and developments in several AI-related fields have been impacted negatively by the pandemic.

COVID-19 AS INHIBITOR OF AI DEVELOPMENT

If we look at the negative impact of COVID-19 on the implementation of Japan`s AI strategy, the priority areas *productivity* and *mobility* can be expected to be affected the most. The current uncertain situation is combined with a near standstill of international trade (in physical goods). Border restrictions and ambiguous supply chains, have huge and lasting negative effects on the global economy, impacting production and consumption.

Although the recent economic forecast of Japan has somewhat improved after lifting the state of emergency at the end of May, gradually increasing socio-economic activities, the current spike of infections could create a setback (Cabinet Office, 2020). The Japanese Cabinet Office announced a 3.4% GDP decrease for the first quarter of the year, a 6% decrease in export, 0.5% decrease of corporate investment and 0.7% decrease of personal consumer investments (Nagata, 2020). The number of employees who were laid off increased by 4.52 million in April to 6.52 million in June (Cabinet Office, 2020). Looking at the long-term projections, while being a wealthy country, the 6th most competitive country in the world, and part of the G7, Japan is expected to have a slow economic recovery and projected to reach the 2019 output level once again only by the end of 2024 (EIU, 2020). This could be the largest economic decline since recording began and exceed the 2008 global financial crisis (Keiko, 2020). Although Japan`s neatly planned AI strategy from 2020 to 2030 is developed with relative stable long-term developments in mind, it becomes clear that due to the pandemic the context in which AI will be implemented in Japan has changed.

So how does this impact the Japanese AI market? Firstly, the decrease in corporate and consumer spending's gives a clue. During a crisis it is likely that luxury goods will be least prioritized

by consumers living through a recession in an unstable economy. Related to this are the developments within the *productivity* pillar of personalized or 'luxury' AI experiences, which are currently relatively expensive for the average consumer. Further developments of AI in personalized systems or AI supporting personalization and 'tailor made' consumer goods, could be delayed until the economic situation has somewhat recovered. In other words, it is unlikely that we will see the normalization of e.g. a non-medical robot butler for the average consumer within the coming years.

Secondly, the *mobility* pillar exists of two components: a physical and a virtual part. The automotive sector, key in the physical part of the *mobility* pillar, as well as one of the Japanese world-class industrial sectors and Japan's largest R&D investor (Greimel, 2019) has weakened. The automotive sector's production and the export of transport equipment has decreased due to COVID-19 (Cabinet Office, 2020). While AI supported self-driving cars did not seem too far out of reach at the beginning of this year, the COVID-19 outbreak has affected investments, developments and interest. In other words, looking at short-term forecasts, the pandemic has negatively affected the transport sector and *mobility* pillar of the AI strategy.

However, the crisis has provoked sectors to re-examine their medium-and long-term plans. It is not unlikely that in the long-run COVID-19's effect on the automotive industry can also inspire AI implementation for data management and autonomous driving technology to support the health and safety of its drivers (PWC, 2020).

POSITIVE IMPACT ON AI DEVELOPMENTS

Although most will think negatively about the impact of COVID-19 on the world's economy, ICT-related exports from Japan showed growth due to a strong demand for 5G and data centers (Cabinet Office, 2020). The possibilities provided by a broad spectrum of AI technology has increased interests as well. The Japanese government is currently planning to invest its R&D budget faster in the core technologies supporting Society 5.0, among which is AI. Comparing these developments to the AI strategy, it implies that the virtual part of the m*obility* pillar, e.g. communication, and the *health, medical care and welfare* pillar are stimulated. As the latter will be described in the next paragraph, the virtual mobility and communication aspects of the AI developments are being described here.

The first area of AI integration in society is telework. Despite the support from the government to normalize tele-working to reduce the strain on traffic over the past year, Japanese businesses have been reluctant toward teleworking (see textbox). The pandemic demanded a reinvention of the employees' home condition to adapt to teleworking, (re) introducing us to several (new) communication tools, supporting the ambitions of virtual mobility part of the AI strategy. AI plays a role as an enhancing and translating technology to improve online communication tools. It

Teleworking in Japan

According to The Japanese Business Federation, 97,8% of its member have instituted teleworking measures this year. This is a remarkable increase compared to the 29,2% in 2019 (Martin, 2020). Despite this increase, it remains important within the Japanese business culture to physically show you are working rather than the work output. The homeworking conditions do not inspire either. For example, 99% of the apartments built in Tokyo are less than 100m^2 (Inamar, 2020), with an average of 64.5m^2 (MILT, 2020). If the pandemic can change the cultural and housing conditions as well, remains to be seen.

can for example recognize background noises like a vacuum cleaner and filter this out in the conversation through machine learning (Protalinski, 2020). Another development helping the integration of AI in society is the lowering of regulatory hurdles. To maintain social distance, many analog ways of working had to go digital, boosting digital initiatives to be adopted like telemedicine and remote education. The necessity to allow digital alternatives gives potential for AI embedded technology the communication, safety and consumer experiences.

AI COVID-19 SOLUTIONS

In this new world, in which humans need to adapt to a new way of living, AI can pose smart solutions for new problems. This brings us to the second priority area of the AI strategy in Japan: *health, medical care and welfare.* AI plays an important part in our fight against COVID-19. By use of AI anomalies can be detected, infection probability can be calculated, inform, personalized content can be analyzed and false information spread on social media countered. AI can also be used to support economic recovery, monitored by satellites, GPS and social media data. Last but not least, AI plays a fundamental role in our ongoing search for a vaccine by predicting old and new drugs treatments (OECD, 2020). Several of these AI application areas are developed in Japan.

Reuters 2020

SoftBanks famous robot Pepper is carefully assisting hotel customers during the COVID-19 pandemic. Together with the cleaning robot Whiz, the two robots keep the hotel a safe and friendly environment. Like its guests, Pepper is wearing a protective mask.
Better safe than sorry.
(Business Insider, 2020)

To start with what Japan is best known for: developing autonomous robots. Mirai's newest invention can drive through public spaces like malls or airports to detect people with fever. It then isolates the infected person and, if necessary, startup a tele-conference with a doctor. The AI technology makes the autonomous navigation, detection and interaction possible (European Commission, 2020).

Another COVID-19 countering application comes from Fujitsu that introduced an AI handwashing monitor. It stimulating employees from health care, hotel and food industries to follow the health ministry's six-step hand-washing procedure by recognizing complex hand movements, which can even detect if people use soap (Japanese Times, 2020). A solution for our personal inconvenience when facial recognition technology fails to identify masked faces is provided by Glory Ltd. Its technology is capable of distinguishing faces covered by masks (NIN, 2020). A final glimpse of the first steps in the Society 5.0 perceived future is Tokyo's robot hotel taking in patients infected with the virus (NOS, 2020). This practical application of AI equipped robots can assist or even replace care workers, especially in situation with a high infection risk. All these developments show that this pandemic is more than a solely discouraging situation. The chaos has sparked innovative ideas, boosted new creatives initiatives and practical AI solutions to overcome this global enemy.

CONCLUSION

AI is booming. The global digital revolution made it possible for AI to prosper and to be used to enhance techniques in sectors beyond their initial intention. In this world altering digital revolution Japan and the Netherlands have their own challenges to conquer. Similar challenges like the talent shortage, the necessity to adapt legislation or being surrounded by nations advancing and sometimes monopolizing techniques, can perhaps be taken on together. While not being as visible as the USA and China within the AI field to date, we do share common values on which we can base our partnership. There is potential in accommodating each other's weaknesses and facing our societal issues together. Topics like our aging societies, agricultural developments or the latest COVID-19 pandemic are providing opportunities to find smart solutions together.

Japan has its own unique approach to designing their society of the future, integrating AI in almost every nook and cranny of this plan. Whereas in Europe there seems to be a focus on software and apps, Japan tend to look at robotic solutions. With Japans focus on robotization and the social acceptance of AI regulated robots, we can see the early signs of Society 5.0 arriving in Tokyo's local supermarkets. At Narita airport, Japans approach to fighting COVID-19 is again with AI boosted robots. Robots welcoming guest, cleaning after them or calling a doctor at once after registering a high temperature, is another development the pandemic has not started but surely increased the necessity of robot employment.

Japan's domestic accommodating environment for developments in new AI techniques, is based on co-creation between the Japanese government, the private sector and of course their knowledge centers. The Japanese government stimulates programs aiming to introduce practical AI solutions for societal problems, invests in research facilities and targets policies and legislation to allow Society 5.0, a huge stimulus for AI, to become achievable. Japan is actively reaching out to AI talent, opening up and subsiding partnerships between universities. This exchange of knowledge and research opportunities is something the Netherlands could benefit from. There is also potential for Dutch entrepreneurs to fill in the gaps within the Japanese AI market. The private sector plays a key element in the Japanese strategy, as their R&D investments make it possible to keep up with the latest developments. Japanese companies like Mitsubishi, Toshiba, Toyota and Hitachi are investing in AI techniques to improve their product and are directing their eyes to the European market.

The Japanese accommodating policies enabling an environment in which AI developments can flourish, come from the necessity to use AI as a core technology in the afore mentioned Society 5.0: a highly technologically driven society in which societal problem are solved by a system which integrates cyberspace and physical space. To reach this goal, AI is appointed as a core technology in several Japanese R&D programs. Stimulus for AI be found at the Japanese Moonshot program, similar to Europe's Horizon2020, and Strategic Innovation Promotion Program (SIP). The AI strategy from SCAIT delivers a roadmap as how and where to apply AI by following three tracks: the productivity, the mobility and the health, medical care and welfare tracks. These tracks are not just planning for the future, but are already put into reality. Right now, Japan is moving to the second phase of their strategy, bringing Society 5.0 closer to the daily lives of the Japanese citizens. With these developments, the digital future infused with AI enhanced robots, once only known from science fiction stories, can become a reality as soon as 2030 for the Japanese population.

Although these ideas are still in the early stages of development, they do demand from us, as an interwoven global community, to redefine what it is to be human and to what extend we want to integrate AI. While AI can be described as a futuristic dream, we cannot be naïve of potential negative impact of (completely) autonomous AI. This is why we should not only collaborate based on economic gains, but also to direct the path humanity takes at the dawn of a human-technology hybrid era. Our first steps to direct the progress of AI based on ethical principles in a human-centric manner, are taken by the joint statement between the EU and Japan to promote a human-centric approach and promising to work together to promote these values.

Japans envisioned future can be very bright for the technology-driven and creative minds. The potential for AI to enhance us as humankind, be it through AI enhanced medical procedures or sustainable smart solutions, has been teased to us, but is impossible to oversee at this stage in time. This future can be promising, if constructed by the hands of those who base their inventions on society oriented peaceful human-centric values. In Japan we see the first examples of their society of the future. Virtual tourism initiatives corresponding with the AI in mobility ambitions, transporting persons through virtual reality anywhere and meet anyone in a matter of seconds, changing the meaning of time and space altogether, have popped up during this pandemic. Society 5.0's productivity track envisioned a zero-waste society in which everything can be personalized to meet your own preferences. And finally, the health, medical care and welfare tracks shows us a future where illnesses can be prevented, the human body be enhanced, modified, and, as some suggest, even the unavoidability of dead can be questioned. Visions of smart cities, bringing all these images together, are already being conceptualized in Japan.

The Netherlands and Japan share multiple similar societal problems. Finding smart solutions might prove more interesting, if not profitable, than perhaps perceived at first glance. It is important to remember that Japan, like the Netherlands, has a problem with the rapid aging society and has come up with several AI infused solutions, like caretaking robots driven. On the other hand, the Dutch are well-known for agritech and water-management, allowing the tiny country to be the second biggest agricultural exporter in the world. Japan, affected by environmental difficulties and, again, an aging farming population, could benefit from AI driven harvest calculations and data analyses or harvesting robots which are already introduced in the Netherlands. Exploring our mutual expertise in answering societal issues through AI, based on shared values, could be beneficial for both countries. Concluding that, in this rapidly changing and hyper digitalizing world, it would be beneficial rather sooner than later, to extend our already 400-year-old relationship with Japan to the AI domain as well.

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