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Fourth Industrial Revolution in Japan: Technology to Address Social Challenges

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I. Introduction

In Japan, discussions on new challenges facing the Japanese society were triggered after 2007 when Hiroshi Komiyama, then president of Tokyo University, pointed out the low birthrate and aging problems, energy and environmental crisis, and risk of extinction of local community in his book *A developed country facing challenges:Japan* (in Japanese). However, the notion of a "developed country facing challenges" publicized in Japan at the time came from the sense that Japan could find solutions to social challenges such as the realization of a low-carbon society and the reduction of carbon dioxide emissions. In other words, it was interpreted as a question of what role Japan could play in realizing a global low-carbon society.

The Information and Communication White Paper published by the Japanese Ministry of Internal Affairs and Communications (MIC) in 2010 shows how the Japanese government was using the agenda of a "developed country facing challenges" at the national level. The Japanese government emphasized that it has the experience and know-how to overcome the social challenges such as the harmonization of economic growth and environmental conservation, rebuilding the natural disaster prevention system, and preparation measures for the low birthrate and aging society.

In February 2016, the Japanese Cabinet Office announced the concept of Society 5.0, vowing to use the technology of the Fourth Industrial Revolution to solve Japan's "social challenges." At that time, the Japanese government recognized that the demand for energy and food has soared along with economic development, the aging phenomenon was inevitable due to the extension of life expectancy, and that Japan's national competitiveness has been shaken by the following strategies of emerging countries. Based on these perceptions, the Japanese government stressed the importance of, first, reducing

greenhouse gas (GHG) emissions; second, increasing food production and reducing losses in the distribution process; third, reducing social costs due to aging; fourth, promoting sustainable industrialization; and lastly, addressing the regional gap and regional extinction.

The global coronavirus outbreak in January 2020 poses a new challenge for Japan: digital transformation. Although the difference between digital transformation and the Fourth Industrial Revolution is not clear, the new Suga cabinet launched in September 2020 was aware of the significance of digital transformation, and it is noteworthy that the cabinet has designated an intensive digital government reform period for the next year, and announced it would establish a new “digital agency” by fall 2021. In the post-coronavirus era, digital transformation will be a new social challenge for Japan, given that the cabinet's emergency economic measures announced in April 2020 highlighted the fostering of remote service industries such as telework, tele-education and remote medicine.

This study focused on the analysis of countermeasures by the Japanese government and companies to address the "social challenges," making use of the innovative technologies of the Fourth Industrial Revolution. An analysis of the healthcare and medical care sectors was conducted in Chapter 2, the manufacturing, mobility, and logistics sectors in Chapter 3, and the local revitalization in Chapter 4 respectively. Chapter 5 concludes by presenting policy implications for the Korean government.

II. The Fourth Industrial Revolution for Addressing Social Challenges in Healthcare and Medical Care Sectors

The reason why Japan earned the evaluation of a "developed but full of challenge country" is that the low birthrate and aging of the country progressed rapidly with the collapse of the bubble economy in the early 1990s. As of 2019, Japan's aging rate, or the percentage of people aged 65 or older, is the highest in the world at 28.4% of the total population, in contrast with Korea (15.1%), China (11.5%), Italy (23.9%), Greece (21.9%), France (22.1%), Finland (21.6%), Sweden (2.2%), and Britain (18.5%). Japan's aging population is creating a sense of crisis in the medical sector. As of 2025, this sense of crisis has been expressed as the "2025 issue" of entering a "super-aged society that mankind has never experienced," where one in three Japanese people are aged 65 or older and one in five people 75 or older. The Japanese government provides nursing services by dividing the older patients who need nursing support into eight stages while in 2025, dementia patients with stage II or higher are expected to increase to double from 2002 to 3.23 million, and patients with stage III or higher are expected to increase by 2.5 times from 2002 to 1.76 million. These aging populations have given the Japanese government the tasks of curbing social costs such as public medical insurance, extending healthy life expectancy, improving lifestyles and preventing diseases, and eliminating the shortage of professionals in medical and nursing services.

The Japanese government has been pushing for "data health reform" since 2017, an approach which aims to solve social challenges by developing ICT and new technologies, and connecting data networks in the health and medical sectors. The data health reforms pursue in detail, first, to build a personal health data integration system (Personal Health Record, or PHR) by assigning an insurance number to individuals, and secondly, to standardize health and medical data systems held by medical institutions. For example, the Ministry of Health, Labor and Welfare has been constructing the National Data Base (NDB) Open Data since 2014 based on medical bills and health examination information. Moreover, the Ministry plans to supplement its existing older nursing DB system by utilizing the VISIT (rehabilitation-related data, collected from 2017) and CHASE (aged care data, collected from 2020) databases, and also implement links between medical data and older nursing data.

The Japanese government introduced the concept of anonymous processing information through the revision of the Personal Information Protection Act in 2015 to enhance medical data utilization by linking medical data with nursing data, and in 2017 the Next Generation Medical Infrastructure Law was enacted to enable the use of medical information without patient consent, while also stipulating accredited anonymous processing medical information businesses to enable anonymous processing of data. In addition, the revision of the Personal Information Protection Act in 2020 established the concept of "pseudonym processing information," laying the legal foundation for information businesses to further utilize personal information in the medical field.

In the private sector, pharmaceutical companies, university hospitals, life insurance companies, research institutes, and IT venture companies are creating new business models using health, medical and older nursing data. The outstanding business models can be featured as below. First, university research institutes and private companies work together to generate anonymous medical big data and sell this to pharmaceutical companies and insurance companies. Second, IT venture companies are developing solution apps using medical information to promote remote medicine support, and to monitor coronavirus home care patients in a non-face-to-face manner. Third, in the insurance industry, sales of health-enhancing insurance linking insurance subscriptions with individual health promotion and improvement of lifestyle are taking place. Fourth, universities and pharmaceutical companies are working together to find new efficacy in existing drugs by combining medical big data and artificial intelligence (AI) in the drug repositioning field.

III. The Fourth Industrial Revolution in Manufacturing, Mobility, and Logistics Sectors

1. Manufacturing sector

Japan has established its status as a manufacturing powerhouse by laying the groundwork for advanced technology, R&D, and efforts to elevate the problem-solving capability of skilled workers at manufacturing companies and human resources at high education levels. Recently, the Japanese government has been implementing a so-called "Connected Industries" digital transformation policy since 2017, amid high concerns over whether Japan will be able to maintain its manufacturing competitiveness. Currently, Japan's leading digital platforms in manufacturing are Mitsubishi Electric's EDGECROSS, Fanuc's FIELD System, Hitachi's LUMADA, DMG Mori's ADAMOS, Komatsu's LANDLOG, and Fujitsu's COLMINA, which only function as IT solutions or software used to introduce smart factory into the manufacturing sites, but do not have an optimization model that encompasses the entire supply chains. In response, the Japanese government is focusing on connecting data separately managed by business divisions or manufacturing factories in the same companies, and expanding the scope of their data use to all the supply chains ranging from raw materials to intermediate procurement, manufacturing, distribution and sales.

In addition to these digital platforms, cases that lead the digital transformation of Japanese manufacturing sector include utilization of AI, IoT, and 5G technologies to enable non-face-to-face operation in manufacturing sites, development of unmanned store operation systems, use of medical surgery support robots, and digitalization of skilled workers' knowhow. For example, considering the rapid increase in demand for "untact" services after the coronavirus pandemic, noteworthy advances have been seen in robot remote control using local 5G technology at Kawasaki Heavy Industries, plant operation through remote verification at SIIX, DMG Mori and Mitsubishi Electric, development of an unmanned convenience store operating system using TX's augmented labor platform (AWP), utilization of surgical support robots at Saitama Medical University, and development of Automatic Guided Vehicle (AGV) and articulated robots at NIDEC Corporation as an alternative to solve labor supply problems. Also, the cases of Nihon Dento Kougyo, LIGHTz, and Polytechnic University of Japan, which aim to solve the problem of the succession of skilled workers' knowhow due to the decrease in the number of working-age population, are also drawing attention.

2. Mobility sector

Japanese-style Mobility-as-a-Service (MaaS) is focused on creating a new mobility service called "On Demand Mobility." Like Korea,

ride-share services are illegal in Japan. Instead, taxi dispatch services using digital platforms are popular in Japan. The business models that are attracting attention as a Japanese-style MaaS are "On Demand" joint bus services, fixed-fee taxi services, and multi-modal services. Of course, these Japanese-style MaaS projects are making great progress in the form of pilot tests and commercialization partnerships between companies and local governments. In particular, MONET Technologies' Medical x MaaS pilot project, led by Toyota Motor and Softbank, is noteworthy in that it has opened the way for remote medicine using vehicles.

The Ministry of Economy, Trade and Industry (METI) and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) are paying attention to MaaS to discover new business models that can address the social challenges of aging and depopulation in the local community, and are pursuing "Smart Mobility Challenge" projects since 2019. The METI selected 13 pilot areas in 2019 to conduct pilot project for MaaS. It is focusing on selecting the driving type or driving area, establishing a mobility data base, expanding unmanned driving services, and developing safety assessment and design techniques. The MLIT is separately conducting a pilot project for MaaS in 19 regions, focusing on infrastructure maintenance projects such as the introduction of AI "On Demand" transportation and the introduction of cashless payments.

3. Logistics sector

Japan's Fourth Industrial Revolution in the field of logistics using IoT or AI, is represented by three business models: logistics P2P matching services, mixed passenger transport services, and unmanned "last mile delivery." However, except for Yamato Transport, which introduced autonomous cars in logistics, and Hitachi, which is developing IT solutions using telematics, overall digital transformation of the Japanese logistics industry remains slow.

The Japanese government is planning to digitalize the entire logistics system by combining logistics data held by shippers, transportation operators and automatized logistics functions. This process is expected to lead to the development of technologies such as platooning trucks, autonomous driving, mixed delivery, and AGV, as well as the development of data sharing and utilization technologies between each logistics hub. However, it is doubtful to what extent private companies will be able to participate in the Japanese government's logistics initiative.

IV. The Fourth Industrial Revolution for Local Revitalization

The Japanese government is pushing for local revitalization policies using the fourth industrial revolution technology to address the problem of local extinction due to income and infrastructure gaps between regions and the mi-

gration of young people to Tokyo. Typical examples are building local online/offline platforms, building 5G network infrastructures, and creating smart cities.

The METI has established more than 100 local online/offline platforms, called IoT Acceleration Labs, to help IT talent and businesses from each region gather on these platforms to solve regional challenges and develop business models that create new jobs. The MIC is pushing for 'regional IoT implementation promotion project' that supports ICT education and ICT implementation plans for small local governments without information and know-how on ICT technology. In addition, the MIC is encouraging local communities to utilize the fourth industrial revolution technologies through IoT pilot projects.

With regard to the 5G mobile communication system, 5G services were commercialized later than Korea and the United States, but Japan is committed to preventing urban and regional gaps, including the launch of 5G services within two years all over the country by setting a mandatory coverage rate of 50% all over 4,500 areas in Japan. In particular, the Japanese government has been reorganizing the 5G spectrum sharing system from 2019 and began conducting pilot tests from 2020 so that local 5G can contribute to innovation in the robot, automobile, and machinery industries where it has competitiveness.

The Japanese government is also paying attention to smart cities that utilize new ICT technologies and public data as a solution to solving local social challenges. In March 2020, the Japanese government released its "MaaS-related data linkage guidelines Ver. 1.0," and in June of the same year, the Electricity Business Act was revised to allow companies to utilize mobility data and power data. In 2020, the National Strategic Special Zone Act was revised to the Super City Act, with the characteristics of: first, smart city operators became able to request public data from the state and local governments; secondly, it stipulated rapid and comprehensive deregulation in the process of constructing smart cities; and third, it cleared the mandatory disclosure of APIs for connection and data sharing between smart cities. In order to strengthen public-private cooperation, the Japanese government established a Smart City Public-Private Cooperation Platform in October 2019, involving 673 organizations, including the Cabinet Office, the Ministry of Finance, the MET, the MLIT and private enterprises, universities, research institutes, and local governments. The Japanese government is conducting various pilot projects to promote smart cities, and one of the representative examples is the Smart City Seeds and Needs project conducted twice by the MLIT in 2019 and 2020.

V. Conclusion: Policy Suggestions for the Korean Government

In Japan, the challenges posed by its low birthrate and aging population expanded rapidly with the collapse of the bubble economy

in the early 1990s, and in March 2011, energy and environmental problems such as power supply shortages and nuclear radiation issues occurred in the wake of the Great East Japan Earthquake and Fukushima nuclear accident. Also, with the beginning of the coronavirus pandemic in January 2020, digital transformation has emerged as a social challenge. In particular, Japan's aging population combined with a decrease in the working age population, has caused the government to face fiscal crisis due to the burden of social insurance, such as public pensions, public medical insurance, and elderly nursing insurance, and a sense of crisis of labor shortage in the medical, manufacturing and logistics sectors. This is also leading to a sense of crisis at local governments as well, seen with the collapse of the medical service supply system under "Tokyo centralization," the rapid increase of the vulnerable in transportation due to the super-aging of rural areas, and the risk of extinction of local communities.

As a way to address these social challenges, the Japanese government has been promoting the active use of technology based on the Fourth Industrial Revolution and digital transformation. Four years have passed since the Japanese government advocated the Fourth Industrial Revolution for addressing social challenges, and this study evaluates that the mechanism for implementing Abenomics' growth strategy policy was relatively stable and systematic. The Korean government also needs to manage its policy system to deal with the Fourth Industrial Revolution in a consistent and systematic manner so that policies related to the Fourth Industrial Revolution do not remain in R&D support, deregulation but lead to social experiments, innovation, new business models and international standards through public-private cooperation and industry-government-academia cooperation.

The policy implications for the Korean government in the healthcare and medical care sector are as follows. First, data standardization needs to be supported along with institutional supplementation to enhance the utilization of healthcare data. In particular, the implementation of various laws should be closely checked, with the expansion of research and commercial use of health and medical big data in mind. Second, it is necessary to collect a wider range of elderly nursing data, such as VISIT, a database on the quality of elderly nursing services in Japan, and CHASE, a database that complements VISIT, and consider ways to improve the quality of the data. Third, the Korean government also needs to devise measures to make remote medicine more common after the coronavirus pandemic. In Japan, remote medicine has expanded its target range from chronic patients and face-to-face patients for more than three months to all diseases and first visiting patients in the wake of the coronavirus.

The implications of Japan's digital transformation in manufacturing and logistics sectors are first, although not in the optimal stage of the supply chain, digital platforms such as Mitsubishi Electric's EDGECROSS and Fanuc's FIELD system are leading the digital

transformation to the level of smart factories. The Japanese government is also focusing on linking digital platforms and expanding the scope of data use to supply chains ranging from raw materials to intermediate procurement, manufacturing sites, distribution and sales. Korean manufacturers and governments also need to pay attention to building and linking digital platforms. Second, amid growing demand for the use of non-face-to-face technology in the manufacturing sector due to the coronavirus pandemic, it is necessary to pay attention to cases of Japanese companies that have introduced AI, IoT, local 5G communication service, non-face-to-face operation through remote manipulation, unmanned store operation systems, medical surgery support robots, smart factory with AGV and robot, and digitalization of skilled workers' knowhow. Third, the Korean government is also focusing on digital transformation in the logistics sector by suggesting three policy directions for non-face-to-face distribution. Nevertheless, Korea's logistics industry or government should focus on measures such as utilizing robotics process automation (RPA) in office work, introducing robotics in logistics warehouses, utilizing AI in delivery plans, telematics in delivery, and sharing logistics resources among logistics hubs.

The Fourth Industrial Revolution for local revitalization in Japan has the following policy implications. First, it is necessary to shift the direction of the Korean government's discussion on regional digitalization support from a supplier-oriented perspective focused on high-tech development to a task-oriented one based on community demand, as seen in pilot tests for smart city and 5G projects in Japan. Second, the integrated and comprehensive regulatory reform measures introduced by Japan in its operation of National Strategic Special Zones are considered very useful, given that the Korean government's Digital New Deal policy also seeks regulatory reform. In the process of applying special deregulation measures to Super City projects, Japanese government also presupposes residents' agreement. Third, Korea was the first country to commercialize 5G service in the world, but the interest in local 5G service by government and businesses seems to be very low. Considering that local 5G is a service that is expected to increase efficiency in smart manufacturing and AI services, the Korean government needs to actively utilize local 5G as a way to revitalize the local economy like Japan has. KIEP