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The Distribution of Technological Innovation & Environmental Policy against COVID-19: Perspectives and Challenges

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Abstract

Purpose: This article aims to explore the distribution of technological innovation and environmental policy challenges to respond to COVID-19. The study also attempts to tackle a paradigm shift in science and technology policies against the pandemic and a desirable direction for environmental policies. The COVID-19 pandemic has been the one that rapidly changed global people's lifestyle. For the spread of a terrible infectious disease could not be avoided, regardless of a highly industrialized society. **Research design, data and methodology:** This study basically employs a qualitative approach as a methodology. This study is based on the fact that environmental pollution, various natural disasters continuously occur, and there are many unforeseeable parts, despite remarkable development of scientific technology, and that the circumstances are becoming more complex. **Results:** This study noted that scientific technology civilization formed due to industrial revolutions can deteriorate environment and increase environmental threat factors. As an alternative to this, this study investigates alternative discussions on how the 4th Industrial Revolution can help scientific technology and human environment to harmoniously coexist and develop. **Conclusions:** It implies that this study focuses on the possibility of overcoming this crisis through science and technology innovation, although mankind is in crisis of COVID-19 due to excessive human development.

Keywords: Distribution of Technological Innovation, Environmental Policy, COVID-19, Risk Society, the 4th Industrial Revolution, National Balanced Development, Climate Change, Carbon Neutrality

JEL Classification Code: I18, I38, L88, O38

1. Introduction: Industrial Revolutions and Change of Urban Environment

Although the past industrial revolutions created high-risk technology society and increased the risk factors of human settlement environment, a possibility that the 4th industrial revolution based on cutting-edge scientific technology can function as an alternative for the harmonious coexistence between scientific technology and environment. This Chapter deals with an alternative discourse on how

paradigm shift into the scientific technology-based urban environment policy should be carried out in terms of direction.

Industrial revolutions made the birth of advanced science and technological innovation, which improved corporate productivity and became an important foundation for economic growth and social welfare. The government regarded technological revolution as the prime value for a nation or region to pursue under the catch-phrase that scientific technological innovation capabilities lead national development. However environmental pollution and various

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disasters continuously occur, and there are many unforeseeable parts, despite remarkable development of scientific technology; rather the circumstances are becoming more complex. This study noted that scientific technology civilization formed due to industrial revolution can deteriorate environment and increase environmental threat factors. As an alternative to this, this study investigates alternative discussions on how the 4th Industrial Revolution can help scientific technology and human environment to harmoniously coexist and develop.

In the modern risk society shaped through industrial revolutions, diverse types of hazardous environmental factors have enormous effects on national and municipal functions, and they are rapidly changing life patterns by penetrating everyday life profoundly. Let's take a look at the effects of COVID-19 for the past two years, which can be a good example. This study started from the following: Discourses on scientific technology and environment thus far have mainly emphasized technical approach and have focused on natural scientific and engineering response methods, and humanities and social sciences discussions on humans and communities have not been sufficiently mature.

The 4th Industrial Revolution, selected as a global agenda in the World Economic Forum (WEF), includes AI, IoT, 3D printing, and nano technology, which have been greatly affecting human lives. Nonetheless, discussions on humanities have not been adequately carried out on how to reduce technological risk dissemination dynamically occurring in the risk society hidden by technical numerical values on environmental goals and symbiotic relationship between scientific technology and environment. In response to COVID-19, it is important to prevent the infectious disease spread, but there is a need to be concerned about how to recover the severance of human relationship and destruction of humanity.



Figure 1: WHO COVID-19 Vaccine Dashboard

Source: World Health Organization (<https://covid19.who.int/>)

Globally, as of 17 February 2022, there have been 416,614,051 confirmed cases of COVID-19, including 5,844,097 deaths, reported to WHO. As of 14 February 2022, a total of 10,279,668,555 vaccine doses have been administered (Fig. 1). With the help of science and

technology, it cannot be denied that the COVID-19 vaccine has exceptionally been developed and distributed quickly around the world. This can be seen as a great advance and achievement in science and technology.

In this study, the discourse on the win-win coexistence of the 4th Industrial Revolution and environment is thought to present a direction for the modern scientific technology development to be headed. Basic discourse on how environmental policy paradigm should shift to implement the virtuous functions that scientific technology shapes the safe and pleasant environment for humans is more urgently needed nowadays when the 4th Industrial Revolution started. Now is the time when developmental discourse on what harmonious relationship between the scientific technology policy based on the 4th Industrial Revolution and environmental policy should be made is important.

2. Issues on Environmental Change and Scientific Technology

2.1. Climate Change Threat and Urban Environment Change

The relationship between human's city history and infectious disease is not unfamiliar historically. Behind the long history of colorful modern cities, varieties of infectious diseases spread have existed. The urban settlement spaces and city dwellers have received harsh punishment of enormous sacrifices due to infectious diseases such as Greek typhoid, cholera in Europe, and Spanish flu historically. Fortunately, dense city spaces provide the favorable environment for economic activities, but they simultaneously provide very favorable environment to the diffusion of infectious diseases. Many social activities carried out in the dense spaces of cities increase opportunities of face to face contact, and are proved that they have become a threat factor promoting the spread of various viruses through epidemiological surveys.

When looking at the types of disasters and accidents in Seoul for the past 600 years, they are not greatly different from the category occurring these days. When examining the disaster and accident aspects in Seoul from the Joseon Dynasty to the modern period (since independence from Japanese colonial rule), there were many damages due to floods, earthquakes, infectious diseases, and famines. The period when remarkable characteristics are displayed from the disasters and infectious in Seoul is the modern period (from 1945 to the present). Because changes in Seoul were bigger than those in recent dozens of years, dynamic image seems to be rather natural. The Korean War that took thousands of people's lives broke out after the liberation from the Japanese colonial rule. Amid coexistence of

political anxiety and economic growth, the infectious diseases were prevalent along with the growth of cities, and very dynamic aspects were shown (Choi, 2018).

Although advanced medicine and scientific technology in the modern society are used to control and respond to various infectious diseases, damages due to them did not disappear or were not eradicated. Rather, they spread to other aspects and so damages are increasing further. Differences on the human point of view regarding infectious diseases exist depending on times, but common things exist in that humans have continuously made efforts to respond to them by taking notice of the changes of infectious diseases through long term observations and experiences (Choi, 2020). Infectious diseases have been spread alongside the growth of cities, and encompass the fierce adaptation process historically. For this reason, current new town development should be carried out in consideration of the COVID-19 pandemic adequately. Infectious diseases may become a more threatening existence based on the unavoidable global trend of urbanization and climate change. Above all, infectious diseases may have not only direct and critical effects on human health, but also may enormously affect humans' everyday life. They play a role in increasing the temporal and spatial uncertainties of risks, and they can expand and diffuse the risks.



Figure 2. Global Distribution Map of MERS

Source: WHO (<http://www.who.int/csr/disease/>)

Before the COVID-19 breakout, an infectious disease MERS terrified Korea in 2015. MERS (Middle East Respiratory Syndrome) Coronavirus into Korea in 2015 led to the largest MERS outbreak. By the end of the outbreak, 186 laboratory-confirmed cases and 38 deaths had been recorded at that time. MERS mainly occurred and spread in the desert area of the Middle East, and it arrived in modernized city of Seoul. The fact that MERS emasculated hospitals equipped with cutting-edge medical facilities and spread vividly shows that infectious disease is no longer the exclusive property of underdeveloped countries. The spread of infectious diseases in Seoul, an international large city, is a serious issue that may determine national competitiveness.

MERS has occurred in 26 countries, including the United States and the United Kingdom (Fig. 2). It was neither a problem of backward hygienic system nor a problem of lacking nutrition state, and so the message that an infectious disease' spread gives to modern cities needs to be sincerely handled. Because infectious diseases are uninvited familiar guests threatening citizens in the city's rapid development process, sincere handling is more felt in our bones. The spread of infectious diseases in cities greatly affect national and local economic activation and development policy, so the meaning of discourses on the new town development and infectious diseases is greater (Choi, 2020; Choi, 2015).

2.2. Scientific Technology and Environment of Risk Society

Discussions on the relationship between scientific technology and environment have existed long before. The 1st Industrial Revolution through which energy could be obtained from fossil fuels and the 2nd Industrial Revolution through which the mass production system was possible using electric power had enormous effects on capitalism and scientific technology. However, as negative perspective on the relationship between scientific technology and environment started to emerge, while environmental problems including depletion of oil and air pollution, when oil and coals were used as energy sources, an assertion that the scientific technology policy should be reorganized from the environmental advantage perspective emerged (Rifkin, 2011). Beck (1992) paid attention to the fact that scientific technology can increase potential risks in the process of scientific technology's promotion of convenience of human life, while referring to a risk society. Giddens (2009) also emphasized that humans' preemptive response discussions is essential, while warning that response in a situation in which seriousness of environmental risk status that may be caused by scientific technology is perceived in his paradox. In Korea, a view taking notice of risks rather than convenience of scientific technology have been active, and the view has been invigorated in connection with environmental movements of civic groups.

Rifkin (2011) presented the 3rd Industrial Revolution, insisting combination of the Internet communication technology and renewable energy. The 3rd Industrial Revolution has focused on the self-sufficient horizontal energy use environment and is expressed as automation through electronic and information technology including the manufacturing industry's digitalization. What is interesting is that the 4th Industrial Revolution emerged in a period similar to the advent of the 3rd Industrial Revolution. World Economic Forum predicted that the 4th Industrial Revolution is already in the entry stage in the Recap of Davos 2016, and expected to have effects on all areas

including society, economy, and population. Schwab (2016) asserted that a new world not experienced in the past can be created by the convergence of new technologies through the 4th Industrial Revolution, and emphasized a proper response to it.

Interest in what can be done with the 4th Industrial Revolution is bigger than the curiosity than what the 4th Industrial Revolution is about. The reason why scientific technology and environment should coexist during the 4th Industrial Revolution age lies here. Climate change, restrictions of natural resources, green economy, and the supply of renewable energy can be the points of contact where the 4th Industrial Revolution and environmental policy meet. In which sector will optimal combination occur in terms of the 4th Industrial Revolution and environmental policy?

3. Setting the Relationship between Scientific Technology and Environment

3.1. Coexistence beyond Conflicts

Along with the advent of new technology including big data and IoT, industrial revolution in a conventional sense is gradually disappearing and the 4th Industrial Revolution emerges as a new paradigm that can replace it. Choi and Kim (2017) present an interesting analysis result of big data from the environmental policy's paradigm change aspect.

First, physical and mechanical aspects in the social perception of industrial revolutions are gradually disappearing, but non-material aspects are emphasized. The frequency of using such words "industry" and "machine" is gradually reduced, but the use of non-material words such as technology is on the rise. This means that the pursuit of humans is changing and that material aspects (machine, etc.) are shifting into non-material aspects (technology, education). This implies that our society's environmental paradigm is changing from material and hardware things to non-material and software things.

Second, although connection characteristics of industrial revolution and environment are slightly different, the word of industrial revolution is in the center. In the 1960s, a trend centered on industry and industrial development was shown; however economic meaning was strongly displayed, and social and cultural characteristics were simultaneously shown in the 1980s. In the 2000s, an abstract and future-oriented meaning was revealed. All these mean that environmental policy paradigm is shifting into a new direction that may lead future change beyond traditional meaning based on machines and industry. However, because the word of forum and so on are still concentrated, it is still early to call the current period the 4th Industrial Revolution

as some scholars point out; discussions on the future seem to be continuously carried out.

Third, discussions on policy response are performed together according to climate change or environmental change that were carried out in the latter part of the 20C. This implies that a meaningful attempt on how the 4th Industrial Revolution is connected to environment has yet to be made. This shows that the 4th Industrial Revolution is more interested in economic profit pursuit through technology development, rather than focuses on solving environmental risks that mankind face, nowadays.

The developmental discourses on scientific technology development and environmental policy imply that scientific technology should have a win-win relationship for harmony between the 4th Industrial Revolution-based scientific technology policy and environmental policy. Above all, they examined how the theme "industrial revolution" has been dealt with within the environmental sector, and showed that how the 4th Industrial Revolution will contribute to environment has not been dealt with, but paradigm shift concentrates on economic logics, although paradigm shift is clearly revealed. To solve environmental problems, discussions need to be mature enough on how the 4th Industrial Revolution should respond to problems such as climate change that humans face beyond new technology development or a commercialization possibility that is intensively discussed at present.

3.2. Community Prospering Only If Humans Live Together Considering Each Other

Emperor penguins in Antarctica fight against severe cold. They do huddling to endure heavy snow storms, although they bear the cold well. If they gather together, the inside and outside are divided, and the temperature inside is known to be higher by 10°C than that outside. Enticement of 10°C warmer can be an irresistible one to the penguins, although they are strong against the cold. Nonetheless, an interesting fact is that the penguins inside move gradually and let the penguins outside come inside as time passes by. It is difficult to find any conflict of right to occupy inside each other. The fact that the whole group turns, that the penguins give way good places, and that they show considerate attitude towards each other is touchy.

Migratory birds take turns for the foremost place each other when they migrate. To birds, the forefront takes a leading bird's energy so much and gives burden, so they take turns the leading role. They instinctively have a hunch that it is a wise method to reduce the whole flock's energy consumption. According to a research, as a result of an experiment attaching a GPS sensor to sacred ibises, the birds followed the other during the 32% of their flight time on average. What is more astonishing is that each bird's time

leading in the forefront almost matches the time that they get help from the colleagues.

In most cases, consideration is accompanied by discomfort and sacrifice. Sometimes sacrifice and discomfort may become a message of joy and love to others, and may become a win-win strategy for the whole society. Since our society concentrates on competition more and more, the animals' strategies to survive through consideration greatly implies to a coexistence strategy between scientific technology and urban environment.

4. Climate Change, COVID-19, and Human Crisis: From the Perspective of Otto Neurath's Boat

Human beings are facing a new urban environment due to climate change and COVID-19. Although the whole world is tightening the reins to achieve zero carbon emissions by 2050, the achievement of the goal has a long way to go. COVID-19 was thought to be solved once a vaccine is developed, but goal achievement of herd immunity has been disappointing due to the advent of COVID-19 variants. Disappointment of citizens who expected to return to normal everyday life cannot be expressed in words. While developing a vaccine against a virus takes years to dozens of years, the threat of variants of a virus quickly and easily come to us only in months, and they seem to be a game that humans cannot win from the start. Nonetheless, we cannot live up and do nothing. This situation reminds us of the Neurath's Boat.

Otto Neurath is an Austrian philosopher and sociologist who advocated the philosophy of logical positivism. "We are in the same position to repair a boat in an open sea. An opportunity to go to a wharf, disassemble the ship and assemble it with good parts is not given to us. Upon taking out a pillar, other pillars should be put in place simultaneously, and we need to use the rest of the boat as a support."

Neurath's Boat should navigate rough open seas one way or another. If the engine breaks down, it should be repaired with the appropriate part remaining on the boat, although there is no same part. If the helm does not work properly, it should be firmly held for the boat not to be capsized by waves (Quine, 1960). Although one may blame on the rough and poor surrounding environment, despite not optimal situation to solve problems, the crew cannot head towards destination without taking any action. Humans are in the position to navigate rough open seas of climate change and COVID-19 and repair the boat like those crew on board the Neurath's Boat. Climate change and COVID-19 are completely dominating mankind temporally and spatially now. There is no place free from the effects of climate change and COVID-19 spatially in the world, and also

climate change and COVID-19 cannot be stopped at any moment temporally. However, carbon is reduced, climate change cannot be stopped for the time being. Perfect control of COVID-19 is impossible and the medicine is the in the same situation as vaccine, although vaccines was developed. Nonetheless, if humans do not take any action, situation will worsen, so the government, individuals, and communities should make efforts for prevention and control of the pandemic. We should not be frustrated, because there are still remaining parts such as vaccine and medicine, although not perfect parts through which the boat can be repaired. We should not give up, but prevent the boat from being capsized. We earnestly hope to safely arrive at the destination of healthy safe society by navigating the rough open seas of climate change and COVID-19.

5. Role of Scientific Technology to Overcome Environmental Crisis: From a Balanced National Development Perspective

Interest in health is huge. Various types of media mass produce information on health. Most news to which people extremely respond is related to health. People's health and health issues including new influenza (H₁N₁) that put whole people in terror in 2009, avian flu that was prevalent in winter of 2013, MERS that caused 186 infected peoples in May 2015, asbestos issue which is a quiet time bomb in life, fine-dust issue called an invisible killer (PM_{2.5}) have become pressing matters (Choi, Bae, & Kim, 2016).

Health has become the most important issue in city life in which infectious diseases threat people's everyday life. It has been almost two years that COVID-19 which was known as a light cold symptom completely changed our daily life pattern. Since the first COVID-19 patient was confirmed in the quarantine process of entrants from Wuhan City, China at the Incheon Airport National Quarantine Station on January 19, 2020, the cumulative COVID-19 patients exceeded 280,000 as of September 2021, and COVID-19 is in the great diffusion trend nationwide. In 2022, Omicron, following the Delta mutation, continues its attack, representing more than 20,000 confirmed patients a day. As of February, the number of patients exceeds 100,000 persons per day. It has been causing 420 million COVID-19 confirmed patients and 6 million deaths worldwide (Fig. 2).



Figure 3. COVID-19 Dashboard

Source: Center for Systems Science and Engineering (<https://coronavirus.jhu.edu/map.html>)

Because fatality rate according to confirmed patients' age shows clear differences, elderly people have very high fatality rate, while it can be just an influenza level to young people. Although the fatality rate (number of deaths/number of confirmed patients) is less than 1% on average, it is still far higher than that of influenza, and so quarantine and control of the infected people is strict. As the confirmed patients' movement paths are open to the public, and self-quarantine is carried out, our daily life pattern has rapidly changed due to the infectious disease control. Because we should avoid face-to-face contact that raises an infection risk, compliance with individual hygienic regulations and strict quarantine control in elementary, middle, and high schools, and universities, communities, and at national level is requiring the completely different urban settlement environment from the past.

Human's defense system construction against infectious disease and pandemic attacks in the history of mankind took dozens of years, and it was successful for only some infectious diseases. Despite steady efforts for pandemic vaccine development in history, there was no case of developing vaccines so quickly within one year like this. It took 25 years to develop a vaccine for Spanish influenza and it took a whopping 43 years for Ebola virus vaccine. From this, we can guess how splendid the potential of modern scientific technology and cutting-edge medicine is.

There is a need to take note to a possibility for cutting-edge medical service and 4th Industrial Revolution to be a new alternative to overcome the inequality of the COVID-19 pandemic. There is a need to pay attention to inequality of the COVID-19 pandemic that its aspect may dynamically change depending on temporal, spatial, and social contexts.

6. Developmental Discourse on Environmental Policy and Technological Innovation: From the Balanced Development Perspective

Climate change and the infectious disease such as COVID-19 not only rapidly change the urban settlement environment, but also can be enormous effect factors to change innovatively the aspects of urban development. For urban development to properly cope with infectious disease threat, urban development receives pressure to give up physical integration and highly-dense development. Urban development is facing a new aspect of contactless eco-friendly spatial development beyond the past development paradigm. Urban spatial structural change to respond to climate change is an avoidable process. To reduce carbon emissions, urban environmental change has become an essential factor, not a choice. Humans have faced a crisis that corporate activities not considering carbon emissions may be withered.

Discussions on climate change and balanced development policy become more complex. The national balanced development policy has been implemented for ease of regional gap thus far. However, such changes as global cities' competition age, free movement of investment capital, decentralization expansion, and the reduction of fiscal space due to increase in welfare expenses are experienced. Overall review of national balanced development policy due to difficult regulations on existing developed regions and not big enough growth or investment expansion of lagging regions than expected is necessary. When looking at the existing regional development projects including growth promotion regions, special situation regions, and general agricultural, mountainous, and fishery regions, KRW 200 billion subsidies have been invested in 150-200 projects a year. Realistically, it is impossible to draw a result to make regional balance through KRW 1 billion-KRW 2 billion per project a year. Climate change in the future society may be a new opportunity. Since carbon absorption circumstances in the non-Seoul Metropolitan Area are good,

They are regarded as more favorable in attracting companies through eco-friendly renewable energy. To this end, efforts to more aggressively attract investments in lagging regions are required in order to realize RE 100 (Renewable Energy 100).

Managing greenhouse gas emissions at industrial/corporate level and at spatial/regional level contain various conflict factors. From the industry economic perspective, although there can be conflicts mainly related to firms' production activities, if carbon emissions management at regional level is carried out, conflicts between Seoul Metropolitan Area and non-Seoul Metropolitan Area may arise. Personally, in case production expenses are added according to carbon emissions management, when other

production factor expenses are the same, the position of non-Seoul Metropolitan Area may be relatively favorable. Not only securing sites for renewable energy production is favorable, but also purchasing cost can be smaller, and production cost may be saved.

A reason why Korean companies claiming RE 100 should be aggressively attracted to non-Seoul Metropolitan Area lies here. In this case, the carbon neutrality policy can contribute to balanced development. Firms' complaints towards production expenses can be higher in general, and the resulting conflicts may increase, and conflicts between local governments to attract those firms may become fierce. Most of all, there can be no problem if carbon neutrality obligation is imposed upon equally to regions. However, if it is less imposed upon Seoul Metropolitan Area, and if it is more imposed upon non-Seoul Metropolitan Area, there is a concern that conflicts between regions may come to surface. Social empathy formation that the Seoul Metropolitan Area and other areas can coexist alongside an all-encompassing communication on conflicts between countries, conflicts between country and local governments, and horizontal and vertical conflicts between local governments is necessary. Win-win efforts at national and urban environmental levels to respond to the 4th Industrial Revolution and climate change and to overcome COVID-19 are desperately needed.

A strategy for co-existence by which regions can coexist and protect environment needs a premise of the innovation of scientific technology. The measures to continue economic growth and minimize carbon emissions, while not withering firms' production activities, are impossible without technological innovation. Technological innovation as an alternative to overcome the environmental crisis in the crisis society functions as a key hub moving two axes, national balanced development and regional economic growth.

The biggest issue facing the earth in the 21st century can be seen as a response to the complex crisis arising from the climate change crisis. The health & security crisis caused by

COVID-19 clearly reveals this phenomenon. The outbreak of pandemics is closely related to climate change. With regard to these context, it is necessary to re-examine the role of technology in the 4th industrial revolution. Science and technology and environmental policies should function as safeguards to manage global risks such as climate change threats including COVID-19. This will establish itself as an important issue along with the creation of new growth engines in the country.

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