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A Transdisciplinary Approach of Crisisonomy for Implementing SDGs in Global Society

- Using the Core System Model and Disaster Resilience Concept -

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Abstract

The purpose of this study is to suggest a framework to implement SDGs (Sustainable Development Goals) by utilizing the transdisciplinary "crisisonomy" approach with the core system model and the concept of disaster resilience. The transdisciplinary "crisisonomy" consists of social activities which find and apply the solutions to social problems, science and technology innovation activities, and technology knowledge to solve problems. The core system model needs to be prepared through a transdisciplinary approach as follows. First, we must set a common goal as the value that society members agree on. Second, we need to provide implementing organizations with laws and guidelines to achieve the values expressed in vision, strategy and action plan. Third, leadership has to ensure that the efforts to implement the SDGs should be effective. Fourth, the successful implementation of the SDGs requires the devotion of ordinary citizens, practitioners, experts and leaders. Finally, we need the expertise in creating new knowledge for SDGs as well as the expertise in the cooperation of citizens and experts.

Key words: SDGs, transdisciplinary approach, crisisonomy, core system, disaster resilience

Ⅰ. INTRODUCTION

Climate change causes not only natural disasters such as heat wave, torrential rain, super typhoon, but also social disasters including ecological destruction, environmental pollution, new types of diseases, and infectious diseases.

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These are serious threats to human life, economic activity and sustainable life. Natural and social disasters caused by climate change are increasing human casualties and economic losses, and their incidence and intensity are increasing worldwide. As climate change progresses in this trend, it is expected that we will suffer more from weather disasters in the future (Kim & Choi, 2016: 136). For example, the World Meteorological Organization(WMO), a specialized agency under the United Nations (UN) that conducts international cooperation and coordination for global climate observations, reported in June 2016 that it has been keeping the "The Hottest Year Record"for 14 months. In addition, the National Oceanic and Atmospheric Administration (NOAA) of the United States analyzed that the average global temperature was about 1.3 degrees higher than one in the time prior to the Industrial Revolution, which began in the 18th century. Due to rising temperatures, polar ice, such as the Arctic Ocean, Greenland, and Alaska, has melted fairly quickly. In the meantime, we are experiencing one aspect of meteorological changes, such as global warming, which is being driven by economic and industrial activities of humankind (Oh, 2017: 16).

In the 1960s, industrialization and economic development of Korea led to rapid urbanization, which increased the risk of major disasters. Also, since economic structure changed from agriculture to industry, a large population has entered the city. Disaster environment caused by urbanization is worsening due to the expansion of public transportation such as subways or buses to solve traffic problems, the increase of high-rise underground-linked complex buildings and multi-use facilities to expand housing and convenience facilities(Shim, *et. al*., 2009: 1).

The deterioration of the disaster environment increases the possibility that a single disaster can develop into a complex disaster depending on the nature of the event or accident. Thus, large-scale damages can be expected to be issued, for example, the 2011 East Japan Earthquake. On March 11, 2011, the Great East Japan Earthquake that occurred in the Tohoku region of Japan was the fourth largest earthquake in the world and the largest earthquake (Mw 9.0) in the history of Japanese observations and the tsunami hit the beach cities such as Sendai City. The collapse of the building and the large-scale fire occurred throughout the metropolitan area including Tokyo, and the damage continued.

As a consequence of the disruption of power supply due to a large-scale tsunami, the first nuclear power plant in Fukushima Prefecture was shut down and developed into a complex disaster with radioactive spills. As of March 2016, the disaster damage caused by the East Japan Earthquake has reached 20,000 deaths and disappearances and 550,000 evacuees. More than 170,000 people are still evacuating. The property damage caused the greatest economic loss due to natural disasters from a minimum of 160 trillion yen to a maximum of 250 trillion yen(Kim, *et. al*., 2017: 1-2).

Korea has been experiencing climate change faster than the global average in disaster safety environment. Also, the temperature and precipitation increase year by year, and there is a possibility of significant natural disaster risk. In addition, the risk factors due to the aging, high-rise and large-scale facilities are increasing, and the vulnerable groups such as the aging population and foreign workers are also increasing steadily. In addition, disasters that transcend borders and new types of disasters resulting from the development of science and technology are increasing. Many people are concerned about the increasing number of special disasters (toxic chemicals, massive power outages) caused by complex disasters and industrialization due to the dense nature of energy (electricity, gas) facilities(Ministry of the Interior and Safety, 2018: 9).

In recent years, the need to develop crisis & emergency management models has increased as disaster increases. The need for a set of standards that apply to crisis & emergency

management practices has been confirmed by local and state officials. Disaster management has been studied by other researchers focused on other aspects of the problem, but there is still no complete and integrated means for disaster management. We can use a research-based simulation approach that combines management requirements, such as critical decision parameters and information, with actual disaster scenarios such as impacts and characteristics. By integrating these models, it is possible to understand and study disaster management, a complex system from a variety of perspectives(Soyler, *et. al*., 2012: 2-21).

The major topic of transdisciplinary research is to find out solutions by using specific problems of the society. It is the study of collaborating with stakeholders and the general public, as well as scientists of various research groups. Transdisciplinary crisisonomy study consists of research activities that find solutions for social problems, science and technology innovation activities that produce new knowledge of science and technology for problem solving, and primary research activities as intermediary activities that produce new knowledge while interacting with them. In theses days, the implementation of SDGs has emerged as a new issue and task in the global society, and a transdisciplinary research approach is needed to produce new knowledge of science and technology to solve these problems.

The purpose of this study is to propose a framework to implement SDGs in crisisonomy by utilizing the core system model, transdisciplinary approach, and the concept of disaster resilience.

II. TRANSDISCIPLINARY APPROACH OF CRISISONOMY

1. Definition of Crisisonomy

The impact of natural disasters on economies in low and middle-income countries tends to be relatively higher than in high-income countries (Halldin, *et. al.*, 2015: 6). Natural disasters are increasingly recognized not only in developing countries but also in developed countries as a major challenge to social stability and prosperity. The enormous costs of single event or series of events caused by natural disasters necessitated the reduction of these costs, vulnerabilities, and exposure.

Organizations that prevent, mitigate, prepare, and recover from disasters have led to new scientific disciplines. The new field of science has grown slowly and progressively and has often been sparked by major events. Scientific progress has been relatively slow, but disciplines contributing to the development of new science have undoubtedly reached a much deeper level of understanding (Halldin, *et. al.*, 2015: 2).

Crisisonomy is a discipline that identifies the nature and cause of crisis that threatens the universal value of humanity and finds rules and laws of crisis & emergency management. This definition is based on the meaning that crisis & emergency management is the process of respecting and implementing human dignity. Crisisonomy, which is a discipline to protect life, dignity and rights of a single human being in the world, and to protect the safety and happiness of the human community, that facilitates an important area of scientific research. The goal and research process of crisis management is to identify the relationship between cause and effect of crisis as well as to find rules and laws to manage it properly. Crisisonomy is used in English to emphasize the meaning of crisis & emergency management which emphasizes the process of finding scientific research and laws. For this reason, Disastronomy is also used in English expressing disaster management. In this paper, Crisisonomy means crisis management science, and Disastronomy means disaster management science. Researchers who have studied crisis management

and disaster management do not have any professional terms to describe disciplines that can systematize crisis management and disaster management study and accumulate research results. There were a number of difficulties in developing crisis management and disaster management into a new discipline (Lee, 2015: 114). It is imperative for scholars to use terminology that signifies a discipline. First, it adds to the depth of academic debate and research, and speeds up the understanding and explanation among related scholars, thereby enabling efficient discourse. Second, it is possible to conduct research and educational activities in the field of study by having academics and practitioners have specialized academic names. They also share awareness of the purpose and methodology of research and education, and enable continuous discussion based on the need for future research. Third, in order to conduct effective research in one discipline and to derive desirable policy alternatives, it is necessary to use terms that scholars and practitioners in the concerned discipline agree. Discourse with different terms and concepts is very inefficient and difficult to reach consensus. It is necessary to summarize the terminology used in the field of crisis management after analyzing and explaining the cause of crisis and establishing the Crisisonomy term for scientific research to discover rules and laws of crisis & emergency management. In order to agree on terms among crisis management experts, it is a prerequisite to establish the term Crisisonomy as a core discipline.

Crisisonomy and Disastronomy refer to the discipline to respect and implement human life, human dignity, and human basic rights, which are universal values of mankind in search of the nature and cause of crisis and disaster, and rules and laws to overcome and manage it(Lee, 2015). In order to emphasize this meaning, we use Crisisonomy for crisis & emergency management science and Disastronomy for disaster management science(Lee, 2015: 114; Lee, 2018).

The academic development of Crisisonomy derives from the fact that dealing with crisis & emergency management only at the practical level is not enough to further develop the national crisis management. The academic development of Crisisonomy has come into conclusion that it is difficult to further develop national crisis management by dealing with crisis management at the practical level. It is difficult to predict the new crisis area and to understand the scale of upcoming damage through discussions with the public officials and the government. It is also difficult to discuss the change of policy system at the macro level. Competition and proliferation of discussion are the best ways to add depth and breadth of all areas.

Therefore, the academic development of Crisisonomy makes it possible for many researchers, practitioners, citizens, NGOs, policy makers such as academics, practitioners, general public, and others to work together. Academic progress of Crisisonomy is possible when all related parties or organizations work together and cooperate to deal with crisis management in the field of discourse.

2. Transdisciplinary Approach and Crisisonomy

Interdisciplinary research[1] beyond the discipline is needed to solve social problems arising from climate change and global warming, avian influenza, particulate matter, water shortages, and urbanization (UN WATER, 2014; UN WATER, 2015). There is a need for developing research methodology for accepting and responding to problems

1) Despite the interdisciplinarity that has been needed and applauded in many studies, there is systematic and academic resistance to such collaboration and methodology. Since interdisciplinary research(IDR) is essential to create new knowledge in the long term, the US National Academy of Science and the US National Academy of Engineering have investigated the benefits and problems of interdisciplinary science (Halldin, *et. al.*, 2015: 2).

in the field of life and for improving citizens' participation. In this context, new discussions such as transdisciplinary research, community based research, and participatory research are emerging.

The controversy over nuclear power, genetically modified organisms (GMOs), and artificial intelligence (AI) has raised interest in the social responsibility of science and technology and acceptability of citizens. In order to strengthen social responsibility of science and technology research, a new paradigm called 'Responsible Research and Innovation' (RRI) is spreading, which means the diffusion of transdisciplinary research methods(Sutcliffe, 2011).

To achieve sustainable development, social, economic and environmental development should go hand in hand. Above all, systematic support for providing basic physical, material, and mental needs of vulnerable groups should be established.

In order to establish this base, it is difficult to accomplish with only one academic field. Therefore, we need research activities beyond interdisciplinary research to find new knowledge and find solutions to global society problems. To do this, activities of humanities and social sciences as well as those of engineers who produce new science and technology knowledge must be connected with each other.

A transdisciplinary approach is essential to effectively deal with disasters that are occurring these days. Disasters are so complex and diverse that they can not be solved by any discipline alone. Therefore, through the transdisciplinary approach, it is effective for experts in each field as well as citizens to analyze a problem from various perspectives and jointly seek solutions.

Transdisciplinary research means that not only researchers but also practitioners and stakeholders participate in the process of knowledge production and produce new knowledge of science and technology and solutions of on-site problems. Their involvements are significant in that they include researchers' experience knowledge and the supply of traditional knowledge that they did not have, and the 'value' that was not covered by existing scientific and technological research (Lim & Song, 2017: 3).

In the meantime, the transdisciplinary research has been carried out in relation to various social problems, such as food safety improvement (Fischer, *et. al.*, 2005: 503-517), building the capacity of the public health workforce (Taub, 2003), health policy research and evaluation (Wan, 2014: 161-177), community energy transitions (Heaselip & Fahy, 2018: 153-163), formalized integrated planning and decision-making in complex system (Wiek & Walter, 2009: 360-370), educational programs for environmental engineers and planners (Menoni, 2006: 309-321), population-environment research for sustainability aims (Hummel, *et. al*., 2013: 481-509), and so on.

In this study, we define transdisciplinary research as a research that fuses and produces knowledge in order to solve the complex and diverse crises that arise in society together with academic experts, stakeholders and ordinary citizens from the perspective of crisisonomy. On the basis of this definition, transdisciplinary research is a research methodology for solving social problems and issues. It is a method of studying various crises that threaten the sustainable development of society, namely, the traditional military security crisis, the disaster crisis (natural disaster, man-made disaster), living safety crisis, and the critical infrastructure crisis.

Characteristics of transdisciplinary research are as follows (Pregernig, 2006: 445-455). First, topics in transdisciplinary research are not determined by scientists, but rather they are mostly about actual problems that arise in everyday life. Thus, it is more appropriate to classify interdisciplinary

research according to the nature and characteristics of the problem rather than disciplinary classifications. Second, transdisciplinary research emphasizes practical problem solving because it aims to help solving life problems directly. Third, because transdisciplinary research aims at problem solving through field application, stakeholders and practitioners can contribute to knowledge production. Transdisciplinary research involves practitioners working with researchers to develop methods and knowledge to solve real-world problems. Transdisciplinary research utilizes a broad, but not clearly defined, set of methods for knowledge generation. While the degree of practitioner involvement varied, very few realized empowerment (Brandt, *et. al.*, 2013: 1). Fourth, transdisciplinary research is a goal-oriented study that focuses on solving problems of the living world and producing a solution that actually embodies the public good by finding commonality of special knowledge (Pohl & Hadorn, 2008).

3. Disaster Resilience

The disaster management system of Korea is composed of four stages including prevention/mitigation stage, preparedness stage, response stage, and recovery stage for comprehensive management of disaster (Byun, *et. al.*, 2019: 4). The prevention/mitigation stage and preparedness stage place before disaster. The prevention stage is composed with activities of evaluating the risk for disaster and reducing risk factors. On the other hand, preparedness stage is composed with activities of developing operation ability for disaster response. The response stage takes place after a disaster occurs, and it involves direct activities of disaster management institutes to minimize damages due to the disaster. The recovery stage involves long-term continuous activities in which assessment for recovering to pre-disaster conditions is necessary (Lee, 2018: 239-242; Yun, *et. al*., 2015: 382-383; Choi, 2014: 574-575; Yang, 2010: 123; Choi, 2010: 210-214). The disaster management system in Korea has improved for solving the problems which occurred during disaster responses. The early disaster management system focused on natural disaster. Then, the initial disaster management system was revised due to the increase of man-made hazards in 1990s. After the Daegu Subway Fire Accident in 2003 occurred, the problems of disaster management system were reviewed and the system was revised for integrated disaster management system (Yeo, 2014: 441). Similarly, the flood early warning system was developed at the Mushim stream after the occurrence of flood disaster in Cheongju city (Azam, *et. al.*, 2017). This system involves the hardware and software based smart technology to develop an early flood warning system for Mushim stream watershed. Warning was developed through sending early flood warning messages in potentially impacted areas. Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) is used for flood alert application which provides the forecast in advance with sufficient lead time. This early flood warning system greatly reduces the risk factor and increase the preparedness against disaster. In addition to this, the attempts have been made to develop drought warning system in South Korea (Azam, *et. al.*, 2018). This helped to reduce the risk factor related to droughts.

The disaster management system has important characteristics such as integrity, learnability, cooperation, and redundancy. Integrity refers to comprehensive disaster management through active information exchange among government organizations in charge of disaster management. Learnability implies that it is difficult to make a prediction on disaster environment and that disaster management organization should have a structure of learning organization for adapting to and controlling the environment. Cooperation implies that disaster management involves diversity and complexity across or

within organizations and that cooperative network should be established for effective disaster response. Redundancy is a significant characteristic for responding to uncertainty of disaster environment. In case of malfunctioning of certain disaster management organization, the extra organization replaces or supports the function of disaster management organization (Chae, 2004: 134-135; Lee, *et. al.*, 2003: 13-20; Kim, 2004: 12-16; Kim & Kim, 2002: 13-16).

According to Holling (1973: 17), resilience determines the continuity of relationships within a system, and has defined the ability of the system to absorb external changes and still be able to sustain the system. Disaster resilience means the ability to mitigate the vulnerability of a community or individual to a disaster, thereby reducing the likelihood of a disaster, as well as restoring the system's ability to a pre-disaster level following a disaster[2] (Yang, 2016: 146). Kang, *et. al*.(2013: 24) define resilience as the ability of the community[3] to systematically restore the performance of a community's system to the level of system performance in normal situations while not significantly reducing system performance levels in normal situations (Kim & Lee, 2018: 89). A system in which disaster resilience is secured reduces the probability of disaster damage. It can also reduce death, injury, economic, social, and psychological damages resulting from disaster and reduce recovery time (Halpern & Tramontin, 2007; Kim, *et. al*., , 2011: 66; Saul, 2013).

In this article, we define disaster resilience as a capacity to make communities more secure for disasters that threaten safety than those before disasters (Lee, 2018b: 77-78). In order to be a safe community, it is necessary to strengthen the capacity of the community system[4] to quickly recover the negative effects of disasters. Most communities are repeatedly subjected to loss of life and property when a disaster of the same magnitude occurs again, and it is a common practice to repeatedly make a hard recovery effort. By strengthening disaster resilience capabilities, it is necessary for communities to prevent, prepare, respond, and recover from disasters and prevent them from repeatedly suffering the same disaster.

III. IMPLEMENTATION OF SDGs USING CORE SYSTEM MODEL

To build a new paradigm for sustainable development and to pursue safe and clean social equality in the global society, we need a system that encompasses quality of life, environmental safety, and economic and social equity. In 2015, the United Nations reaffirms SDGs as a new development paradigm for humanity and adopts 17 SDGs to jointly work toward achieving the goals of the world. Because Korea is vulnerable to disasters caused by climate change and weather changes, a new paradigm of Crisisonomy is needed to secure quality of life and safety based on the UN SDGs for safety and happiness of human society.

System theory in the 1950s and 1960s were new theoretical perspectives for understanding and predicting natural and anthropogenic phenomena. This is distinguished from the approaches adopted in many scientific disciplines with historical, reductionist, and behavioral methods in scientific inquiry. General system theory was a new

2) Mayunga(2007) proposed the concept of 'Community Disaster Resilience' by approaching Disaster Resilience from a community perspective (Mayunga, 2007).

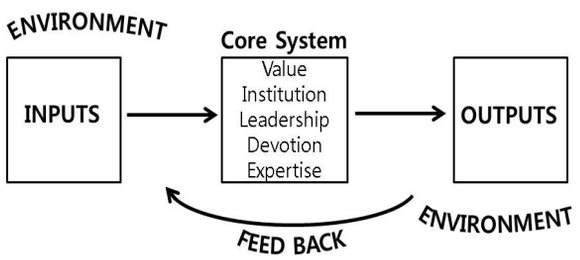
3) Berkes and Ross contributed to establishing the concept of community resilience by organizing and integrating the two streams of the existing resilience concept approach, the social-ecological system and the psychological-social approach (2013: 5-20).

4) Recently, in the field of sociology, there is a study that conceptualizes the resilience as "relational resilience" in terms of the possibility of change (Hale & Carolan, 2019).

paradigm for scientific inquiry into the totality, interrelationship and mutual dependence. Up to date, the system approach has had great influence in most disciplines and professional fields. A system refers to a set or arrangement of related objects or concepts to form the whole. All systems are generally described using system concepts such as input, conversion, output, feedback and feedforward loops, equilibrium, homeostasis, and open and closed systems. The system consists of a number of interdependent parts that function as a whole for some purpose. General system theory integrates knowledge of various specialized areas to better understand the system as a whole (Certo, 1989: 44).

What is a core system? A core system is a network hub that leads and coordinates an entire system to a certain direction (Lee, 2014: 23). The conversion process of the system can be regarded as a black box for various input factors of the system in the model. We have explained and understood social and political systems without deep understanding of the conversion process. Now it is mandatory to understand the realities of the process of converting inputs into output and to understand the functions and roles of conversion process accurately to improve comprehensive understanding of the core system. Figure 1 depicts the core system that constitutes the conversion process that has been regarded as a black box.

The core system consists of value, institution, leadership, devotion, and expertise (Lee, 2014: 23; Lee, 2016: 21). First, value can be defined as determining the direction



※ Source: Lee(2014: 23).

Figure 1. Components of Core System

of system operation in situations such as disasters, public events, and events. If there is no value to give direction, the system will wander in the woods without purpose. In order to achieve the goal, society must have desirable values and philosophies that society members generally agree and accept.

Second, in order to achieve desired goals, the system should create sub-systems that society members can accept socially and legally. The core system can gain legitimacy to perform required functions or missions through relevant institutions. Especially, in the case of social systems or political systems, it is necessary for the legitimate institutions to perform official duties in achieving their goals.

Third, leadership is a vital element in system management when the system is operating on the basis of good value and legitimate institutional basis. Leadership is an important factor affecting the operation of the system in terms of achieving goals and performing cooperative tasks of members. Leadership is an essential element in the successful operation of systems that must achieve common tasks. In order to facilitate successful task performance, it is necessary to understand and consider leadership performance in core systems.

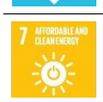
Fourth, if the system is to accomplish the task successfully and achieve its goal, the system requires devotion of the members. The devotion of the members in the core system to operate the system will contribute to the development of a better system. A core system that has secured the devotion of its members can have a strong impact on system members to perform essential tasks.

Finally, the system should have expertise necessary to perform relevant tasks. Expertise is special knowledge or knowhow that can be gained through practice, training, and research, etc. As jobs become more specialized, the system relies on its expertise to achieve its goals. Expertise

is the basis for all the tasks for managing a system.

Changes in the environment surrounding the system can threaten the expertise of the core system. It should be recognized that these threats to the core system can be

Table 1. Implementation of SDGs and transdisciplinary approach of crisisonomy

UN SDGs	K-SDGs	Local-SDGs	Contents
	Eradication of Poverty	Protection of the Vulnerable	Establishment of System for Protecting the Vulnerable
	Food Security for Vulnerable groups	Systematic Protection of Disaster Victims	Establishment of System for Protecting and Supporting Disaster Victims
	Reduction of Climate Change Disaster	Responding to Climate Change	Establishment of Disaster Management System to Climate Change
	Gender equality	Analyzing the Disaster Vulnerability from Gender Equality	Disaster Vulnerability Analysis for Gender Equality
	Partnership	Transdisciplinary and International Action	Transdisciplinary and International Crisis & Emergency Management
	Industrial Safety Innovation	Corporate Investment for Safety Facilities and System	Establishment of Sustainable Disaster Safety Industry and Corporate Safety Management System
	Creating a Job in the Field of Safety	Educating Experts and Jobs in the Field of Safety	Education for Experts and Jobs in the Field of Safety
	Responsible Consumption and Production	Establishing Living Safety System	Establishment of Living Safety System: Food, Pharmaceuticals, Health Functional Foods, Industrial Products
	Urban Community	Urban Safety and Disaster Prevention	Establishment of Urban Safety and Disaster Prevention System
	Safe Drinking Water	Supplying Safe Drinking Water	Establishment of Supplying System of Safe Drinking Water
	Clean Energy	Disaster Management Utilizing Renewable Energy	Establishment of Disaster Management Utilizing Renewable Energy
	Health Wellbeing	Public Health Environment	Establishment of Public Health Environment for Sustainable Safe Community
	Marine Disaster	Transdisciplinary Research of Marine Disaster	Development of Transdisciplinary Research of Marine Disaster Management
	Diversity of Land Ecosystem	Transdisciplinary Research to Ecological Disaster	Improvement of Transdisciplinary Research of Ecological Disaster Management and Diversity
	Inequality mitigation	Implementing the Equitable Safe Society	Implementation of the Equitable Safe Society
	Safety Education	Educating Experts of Crisisonomy	Establishment of Education System for Experts of Crisisonomy
	Safe Community	Establishment of Safe Society	Establishment of Crisis & Emergency Management Resilience System

reduced by accepting new experts and training existing actors.

From the perspective of Crisisonomy, the implementation of SDGs using core system model is as follows. First, it is necessary to set social common goals that SDGs should pursue. Looking at the 17 SDGs goals, each goal is comprehensive and has a significant meaning in human society. Therefore, it is necessary to share the meaning of the 17 goals of the SDGs and to provide a common meaning to give importance to them. In order to achieve the goal, society must have desirable values and philosophies that society members generally agree and accept. As emphasized by transdisciplinary research, we must establish desirable values and philosophies that all members of society can agree and accept.

Second, to achieve the value of the SDGs implementation goals, the law, administration, organization, budget and manpower should be institutionalized. It is necessary to establish legislation, administrative procedures, an organization that implements SDGs, and secure budget and manpower. It is necessary to understand the SDGs implementation goals and to establish a control tower to manage and operate law, administration, organization, budget and manpower to achieve them. It is an important task to establish cooperative relationships among these agencies and departments, because the agencies or departments that implement the SDGs goals are dispersed.

Fourth, SDGs are made up of contents essential to ensuring a sustainable life for the community and people of human society. The human resources involved in carrying out these tasks are required to understand the value and importance of their work in order to achieve their fulfillment goals and to devote their best efforts to fulfilling their partnership with related stakeholders and organizations. The devotion of the members of the core system to the operation of the system will contribute to the development of a better system. A core system that has secured the devotion of its members can have a strong impact on system members to effectively perform essential tasks.

Fifth, the system implementing the SDGs goal must have the expertise required to perform the task. In order to equip the expertise in terms of the institutional aspect, participating personnel should have expertise on SDGs content. They should also have technical expertise related to system operation, organization, and cooperative network operation. Technical expertise refers to special knowledge or know-how that can be gained by practice, training, research, and so on.

Also, it is supposed that it would be possible to develop performance indicators for community safety in SDGs through transdisciplinary research. In general, the performance indicators of ODA projects related to community safety are as follows.

Table 2. Performance indicators of SDGs and transdisciplinary approach of crisisonomy

UN SDGs	K-SDGs	Local-SDGs	Performance Indicators
	Eradication of Poverty	Protection of the Vulnerable	• The number of health promotion program participants
	Food Security for Vulnerable groups	Systematic Protection of Disaster Victims	• Reinforcement of administrative institution competence for reduction of disaster-vulnerable households • Reinforcement of civil society competence for reduction of disaster-vulnerable households (The number of support beneficiary associations, etc.)
	Reduction of Climate Change Disaster	Responding to Climate Change	• Greenhouse gas (CO2) reductions (tons CO2-eq) • The number of national greenhouse gas inventory constructed

Table 2. Performance indicators of SDGs and transdisciplinary approach of crisisonomy (continued)

UN SDGs	K-SDGs	Local-SDGs	Performance Indicators
	Gender equality	Analyzing the Disaster Vulnerability from Gender Equality	• Reinforcement of administrative institution competence to prepare for gender-based disaster vulnerability • Reinforcement of civil society competence to prepare for gender-based disaster vulnerability (The number of support beneficiary associations, etc.) • The number/ratio of activities to overcome disaster vulnerability led by women
	Partnership	Transdisciplinary and International Action	• The number of international organizations invited for response to disasters and business agreements
	Industrial Safety Innovation	Corporate Investment for Safety Facilities and System	• The number of industry-university-institute disaster safety research development tasks • The number of industry-university-institute disaster safety technology transfers/businesses
	Creating a Job in the Field of Safety	Educating Experts and Jobs in the Field of Safety	• The number of disaster safety technology startups and new jobs created • The number of organizations moving into the disaster safety and innovation cluster
	Responsible Consumption and Production	Establishing Living Safety System	• The ratio of households with improved kitchen structure/cooking stoves • Institutional improvement for food and drug safety management
	Urban Community	Urban Safety and Disaster Prevention	• The number of IT security system applications • Residents' satisfaction with/confidence in public safety improvement of the target area • The number of residents' reports or complaints in the target area • The number of infrastructure beneficiaries
	Safe Drinking Water	Supplying Safe Drinking Water	• The number of households/hospitals/health centers/schools with safe drinking water • The number of households/hospitals/health centers/schools with improved sanitary facilities/toilets • The number of people who are capable of drinking 20 liters of clean water a day • Sustainable approach to and use of improved water resources
	Clean Energy	Disaster Management Utilizing Renewable Energy	• The number/ratio of population relying on fossil fuel and technology • The ratio of population relying on clean fuel and technology primarily (%) • National energy policies, laws, strategies and plans • The scope of diffusion of new renewable energy to other areas • The number of new renewable energy infrastructure constructed or improved • The number of new renewable energy supply and revitalization system introductions • Electricity production of new renewable energy (kWh) • The number of new renewable energy-related advice and training beneficiary (governmental) institutes, businesses and trainees • The number of households that are capable of using climate-resistant energy service
	Health Wellbeing	Public Health Environment	• The number of residents receiving a medical checkup
	Marine Disaster	Transdisciplinary Research of Marine Disaster	• Accuracy of rainfall/precipitation observation, flood forecast • The ratio of households exposed to the risk of flood/drought • The rate of data analysis time reduction (%) • The rate of forecast accuracy increase (%)
	Diversity of Land Ecosystem	Transdisciplinary Research to Ecological Disaster	• The rate of spare time for evacuation before disaster occurrence
	Inequality mitigation	Implementing the Equitable Safe Society	• The number of teachers that went through the gender-sensitive curriculum • Corruption perception index
	Safety Education	Educating Experts of Crisisonomy	• The ratio of deteriorated schools for support with an age of 30 years or above • The number of schools with improved facilities • The number of climate change response education programs
	Safe Community	Establishment of Safe Society	• The number of international organizations invited for safe society and business agreements

※ Source: This table was reorganized, based on the 2019 data of the Development Cooperation Bureau in the Ministry of Foreign Affairs (Ministry of Foreign Affairs, 2019).

Ⅳ. CONCLUSION

We need to do transdisciplinary research because social, humanistic, engineering, and medical sciences are diverse and connected with human life. Transdisciplinary research has the following effects. First, through transdisciplinary research, it is possible to draw practical and academic issues on sustainable development of human society, to draw up new research themes, and to lay the foundations for further academic research. Second, through transdisciplinary research, it is possible to create a new knowledge about the establishment of a safe community as well as a balanced development in related disciplines. Third, through transdisciplinary research, citizens can discuss the importance of sustainable safety societies together with professional researchers from the various disciplines such as public administration, business administration, consumer studies, literature, arts, social welfare, crisisonomy, disastronomy, health science, medicine, engineering, IT, AI, and so on. Fourth, through transdisciplinary research, it is possible to link theory and practice of scholars and practitioners and to advance social systems. Fifth, it is possible to expand research findings into educational programs in the field of crisisonomy and disastronomy, to educate experts to solve social problems in each field. Sixth, through transdisciplinary research, democracy can be developed one step further by having systematic knowledge of decision-making process for citizens to solve various social problems.

As a result of this study, we propose the following suggestions for the implementation of SDGs goals through transdisciplinary research from the perspective of crisisonomy using the core system model.

First, in order to successfully implement the SDGs, we need to set a common goal, which is based on the value that society members agree on. The common goal is a vision pursued by the members of society, and should be presented in the form of strategies, goals, and action plans to achieve them.

Second, we must provide necessary institutions such as implementing organizations, laws, and guidelines to achieve the values expressed in vision, strategy, and action plan. It is also necessary for citizens and experts to monitor whether these systems function properly. It is necessary to develop, measure and analyze indicators to objectively check whether the SDGs is properly implemented.

Third, economic, social, cultural and academic leaders as well as political leaders must exercise strong leadership to ensure that efforts to implement the SDGs are effective. A control tower including supporting organizations and functions must be equipped to effectively exercise leadership.

Fourth, successful implementation of the SDGs requires the devotion of citizens, practitioners, experts and leaders. A culture that acknowledges and respects the dedication of participants should be created within society. Governments of each nation, civil society and corporate should cooperate based on trust, which is social capital.

Finally, we need expertise in the creation of new knowledge as well as in SDGs and the cooperation of citizens and experts. We must make an attempt to implement SDGs in diverse areas of everyday life and disciplines based on expertise through transdisciplinary research.

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