THE IMPROVEMENT OF DAM CONSTRUCTION AND MAINTENANCE THROUGH THE 4TH INDUSTRIAL REVOLUTION TECHNOLOGIES

By

KIM, Hyun-Seok

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

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EXECUTIVE SUMMARY

The 4th Industrial Revolution is attracting attention as a new momentum for innovation growth that can simultaneously solve 'economic and social structural tasks' based on the intelligent revolution. The 4th Industrial Revolution induces revolution in the national economy and society, including industrial terrain, employment structure, and people's lives, and determines future competitiveness in accordance with successful responses. The rapid transition to the 4th industrial age is taking place in all fields not only in Korea but also all over the world. In particular, the construction industry is highly recognized as a 3D industry, and the inflow of younger people is very disadvantageous compared to other industries, and the technical manpower shortage is serious. In order to solve this problem, it is necessary to inject automation technology into the construction industry. In addition, the introduction of smart digital technology, such as acquiring accurate information, is absolutely necessary in order to efficiently manage aging dams and rapidly changing climates. Accordingly, K-water Dam construction and maintanance methods need to be improved by integrating ICT and IoT technologies appropriate for the 4th Industrial Age. Accordingly, K-water's problems and solutions were proposed in order to introduce 4th Industrial Revolution Technologies through case studies in advanced countries.

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Chapter 1: Introduction

1.1 Background

Recent technological advances have evolved to a level where human intervention is minimized to enable the performance of some intellectual judgment as well as human physical labor. This is proof that a new era of revolution, the 4th Industrial Revolution, has arrived.

The human race has experienced three revolutionary changes in society, including industry, income distribution and culture, thanks to innovative technologies developments. (1^{st} mechanized, 2^{nd} industrialization, 3^{rd} informatization).

The above core technologies changed not only the industrial structure, but also society and life as a whole, including high-income jobs, urban size, and lifestyle. As such, the 4th industrial revolution will revolutionize the entire economy, including industry, employment structure, and people's lives, and determine future national competitiveness based on successful response. Already, advanced countries recognize the fourth industrial revolution as a core task of growth and a solution to social problems, and the public and private sector are actively pursuing to develop intelligence together. In particular, the high-tech science and Information and Communication Technology(ICT) are expected to play the role of the enabler and key means of innovative growth. However South Korea has seen continuous decreases in the ICT investments since 2001 and now, as a result, has the lowest among OECD member countries. It needs to invest more and develop its capabilities for core technological innovations.

Even with the world's highest-level network, which is the basis of the 4th industrial revolution, the core technological competitiveness that will lead the entire economic and social

revolution is vulnerable. Accordingly, Korea has established a dedicated ministry called the Fourth Industrial Revolution Committee for the Fourth Industrial Revolution era and is responding. With the rapid, recent transition from all sectors to the fourth industrial era, K-water also needs to improve its dam construction and maintenance.

This research paper will attempt to answer the following research questions : 1) What are the 4th industrial technologies that can be applied to construction and management? 2) How can smart technology be used efficiently in construction and management?

1.2 Research Problem

In particular, there is a high perception that the construction industry is a 3D industry (Difficult, Dirty, Dangerous).

In order to solve this problem, the construction industry also needs to inject automated technologies. In addition, the introduction of smart digital technologies such as accurate information acquisition is absolutely necessary in order to efficiently respond to aging dam management and rapidly changing climate.

Recently, the nation's construction industry is facing a crisis. This is because both public and private sectors are expected to face difficulties due to reduction of SOC investment.

Therefore, the keyword that the local construction industry has been paying attention to these days is 'Gaining global competitiveness.'

Currently, most of the nation`s major construction companies are striving to expand their overseas orders by strengthening their operations management sector to gain a competitive edge in the global market. However, expanding overseas orders is not an easy task. In the past, the biggest competitive edge for domestic builders in overseas markets was cost-effectiveness. In fact, the price competitiveness of domestic construction companies and the sincerity of the labor force played a major role in changing the overseas buyers' perception of Korean companies. The problem, however, is that Korean builders are now complacent with status quo because they believe that they are still cost-effective. Contrary to the belief, however, the current price competitiveness of Korean construction companies is lagging behind not only Chinnese but also some European builders. As such, the government is clearly aware that strengthening global competitiveness is an urgent task. To that end, Prime Minister Lee Nak-yeon said that "Future construction markets demand convergence with high-tech science such as ICT and artificial intelligence." Land, Infrastructure and Transport Minister Kim Hyun-mi said tha "For the construction industry to become a high value-added business that drives healthy growth of our economy, it should be a year of focusing its capabilities on innovation of industrial structure."

As such, K-water, a leading company in the nation's water resources, must develop and introduce technologies and capabilities as soon as possible so that it can compete in the 4th Industrial Revolution and become a global company. In particular, smart digital technology is essential for efficient K-water dam construction and maintenance. This is because the weather forecast for recent climate change is difficult and construction condition is exposed to dangerous and incomplete.

This paper will be examine ICT civil engineering technologies and examples from advanced countries and propose ways to apply the fourth industrial technology to K-water dam

construction and management for the search for innovative dams construction and management methods that embrace the new paradigm of the 4th Industrial Revolution.

1.3 Research Objective

This paper will cover the detail information of the construction sector in response to the 4th industrial revolution in the advanced country, Korea's policies on the 4th industrial sector, the current problems of dam construction and maintenance, and how to improve it. But it will mainly focus on research on improving dam construction and maintenance basis on the 4th Industrial Revolution. Also, the final part of this paper will provide recommendations and conclusions for the study.

The outcomes listed below are the whole objectives of this research.

1. Information on the core technologies of the 4th industry
2. Status of construction industry in advanced countries by applying technology of 4th industry
3. Proposal for Improving K-water Dam Construction and Management for Fourth Industrial Revolution

1.4 Research Structure

The structure of this study consists of seven chapters. Chapter 1 describes the background of the study, the problems of the current situation, and the purpose of the study.

Chapter 2 provides information on previous research literature related to the study. Chapter 3 provides information on the current status of implementation in relation to the Fourth Industrial Revolution, including government policies. Chapter 4 provides information on the status of implementation advanced countries in relation to the Fourth Industrial Revolution. Chapter 5 describes the key technologies related to the Fourth Industrial Revolution. Chapter 6 describes K-water's future vision and challenges. The final chapter describes the conclusions and recommendations of this study.

Chapter 2: literature Review

As I mentioned in my haste, the recent increase in interest in the technology related to the 4th Industrial Revolution is making efforts to respond to these technologies worldwide. In particular, ICT technology is being utilized in the construction industry.

According to Han's report (2017), the recent analysis of trends in the patent field of construction technology shows a marked increase in ICT construction patents. However, ICT construction patents are not evenly distributed in all areas of construction technology and are concentrated in specific areas of construction technology. The focused ICT construction technology was shown as construction and material technology. In contrast, in the case of facility safety and maintenance technologies, it was 1% of the overall weight. However, recently safety and maintenance of facilities have emerged as a social issue due to abnormal weather conditions. Therefore, it is the most urgent area for introducing ICT. Also, Han (2017) mentioned that the

development effort to integrate ICT technology into construction technology has been less active over the last decade than expected. In case of other countries, the Drone, one of core technologies of the fourth industry, can be used to Safety management of hydrology facilities and used cases in various fields are provided.

Agoston Restas (2015) presents disaster management activities using drones before, during, and after the disaster, discusses relevant technologies, and proposes ways to utilize drones in earthquakes, floods, and forest fires.

Stuart M. Adams and Carol J. Friedland (2012) suggests that the use of drones in evaluating, responding to and managing disasters is a very active study area, and that they are very useful for aerial filming for in the recovery efforts. In the case of hurricanes in the U.S a well as earthquakes in Haiti and Japan, the use of drones has proven very useful for collecting images of disaster damages.

Mark Harvey, Colin Harvey, Julie Rowland and Katherine Luketina (2016) states that drones are routinely used to collect aerial images and create digital altitude models. In particular, the possibility of collecting and analyzing heat related information about terrain that is difficult to access using lightweight thermal sensors is suggested. In this study, information on monitoring the stability of old dams and environmental changes of reservoirs through the use of thermal infrared cameras is available.

Valker Eick (2010) suggests that drone monitoring and control technologies began and evolved gradually from the beginning of World War I through military use, and that infrastructure such as reservoirs can be monitored and used for environmental improvements. Through this study, a plan for applying dam safety management using drones is proposed.

Chapter 3: Related Technology for 4th Industrial Revolution

It is the 4th industrial revolution technology that frequently appears in the discussion process of the 4th industrial revolution, and various technologies are being proposed. Schwab proposed unmanned transport, 3D printing, robotics, graphics, Internet of Things, blockchain systems, genetics, synthetic biology, and gene editing.(Klaus Schwab, 2016) and Berger proposed sensors, 3D printing/layer manufacturing, nanotechnology/high-tech materials, robots, automatic transmissions, high-tech manufacturing systems, big data, cyber security, logistics 4.0, mass customization, the Internet of Things, and future resources.(Ronald Berger, 2016) Examples in construction include technologies such as 3D printing, big data, drones and BIM, which are important 4th industrial revolution technologies, while other studies include VR•AR, robotics, future new materials, and the Internet of Things.(Construction Economy, 2017) Although the 4th Industrial Revolution ICT technologies presented by the authors vary, the most representative, iterative and commonly referenced ICT technologies related to construction were BIM, IoT, Drone, GIS and 3D printing.

This paper sets out to focus on the use of drones. The use of drones is already commercialized in various fields, from personal hobbies to commercial drones, and the area of use is steadily increasing. Although drones were first developed and used for military purposes, they have expanded to personal hobbies and are now the representative areas of video and photo shooting using cameras. There are also various hobbies such as racing drones, which use racing drones to compete in races, and simple photography as a hobby. Commercial drones are used for

agricultural drones, shipping, process control in construction, and quantity calculation. A typical use of agricultural uses is the spraying of agricultural chemicals. First of all, large-scale farms will use drone cameras and thermal image cameras to identify areas where vermin are plentiful and areas where growth of plant is poor. The information is then used to determine the amount and spraying area of the pesticide so that the drones can automatically spray the pesticide, and if the pesticide falls off, the drone will return to recharge themselves, and automatically fly back to the point where the spraying is completed.

In the disaster sector, it is currently used for forest protection activities and transportation of supplies and recovery from fire sites. An example of emergency relief supplies is the successful mock training to automatically run to the address entered into the GPS in the drone and deliver medical supplies to the target location. Currently, a study on the application of disaster management using drones in the water resources field is conducting on the acquisition of river's topography information. Utilization studies such as water quality observation, flow rate survey and flow characteristics monitoring by using drones are very insufficient. In foreign countries, Japan is using emergency response for river and marine disaster management, high-resolution survey data for stream maintenance and management and 3D data acquisition using high-resolution photography. The applicable areas for safety management of water resources facilities are monitoring pollution levels and pollutants all the time, generating pollution maps, monitoring dangerous areas, investigating drought, flood damage, and monitoring. However, it is lacking where drones are used for safety management of water resources facilities. The following table shows the technical level and problems of drones that are utilized in safety management and construction field after investigating domestic cases related to safety management during drone-based studies.

Researcher	Subject	Method & Content	Opinion
Kim, Moon, Lee	√Development of location detection technology for buried people on disaster-collapse site using drones	☞ Proposal of technical measures such as detection of buried people in disaster areas based on drones and obtaining information on the shape of the collapse in order to detect the location of the victim in the event of a facility collapse in urban areas ☞ A Proposal for the Necessity Development of Life Saving Information Technology in the event of a Disaster	▶ Need to acquire drone-based configuration information and develop detection technology ▶ Specific technical development research not conducted and limited direction
Kim, Lee, Choi	√A Study on the Possibility of Using Unmanned Aircraft in the Mudflat	☞ Produce information on coastal mudflats using unmanned aircraft and provide an analysis and review of accuracy of numerical elevation models	▶Only one working case ▶Identifying various problems and presenting limited improvement measures
Son	√A Study on the Maintenance of Military and Defense Facilities Using Dron	☞ Using drones to photograph military facilities and obtain 3D object data to provide technology for checking the condition of the facilities	▶Extracting the method of regularly maintenance application and maintenance application ▶Discussions are focused on current conditions rather than specific proposals for improvement
Kim	√Application of Unmanned Aircraft to Construction Sites	☞ A Comparative Analysis of Existing Earthwork Volume VRS Calculation Method and Small UAV Data for Updating Water Level and Evaluating Soil Volume Accuracy	▶Limited one experimental data, less reliable technology
Shin	√Risk Assessment of Flood Disaster	☞ Assess and analyze flood hazard risks by reservoir by evaluating disaster risk index ☞ A Study on the Utilization Plan, such as Selection of Priority to Improve Existing Reservoir Facilities	▶Suggestion of a methodology for assessing flood hazard risk in a reservoir

Chapter 4: Status of Promotion for 4th Industrial Revolution in Japan

4.1 Japan's Response to the 4th Industrial Revolution

The Japanese government's response to the 4th Industrial Revolution is represented in the Ministry of Economy, Industry and Energy's New Industrial Vision and the Ministry's Strategy for Reconstruction of Japan(2016). The Department of Land, Infrastructure and Transport decided that the key to the growth of the construction industry was to increase productivity, and the Minister of Land, Infrastructure and Transport established a productivity revolution headquarters with all the heads participating, and set up 20 representative productivity revolution projects.

	Project
1	√ Pinpoint congestion countermeasure
2	√ The fare system for wise use of highways
3	√ Cruise Realization of a New Era - For Cruise Travelers Visiting Japan
4	√ Compact Plus Network - Increasing productivity in a dense economy
5	√ Promotion of the Optimal Real Estate Situation - Reinvestment of Real Estate and Expansion of Market
6	√ **Infrastructure Maintenance Revolution - Driving clear and efficient infrastructure maintenance**
7	√ **Dam regeneration - early improvement of the flood ability to support local economies**
8	√ Aviation Infrastructure Revolution - Best Combination of Airport and Control

9	√ **Implementation of I-Construction**
10	√ A New Development of the Housing Life Industry
11	√ I-shipping and j-Ocean - maritime productivity revolution, strong industry, high growth
12	√ Logistics Productivity Revolution - Efficient and high value-added smart logistics
13	√ Road logistics innovation - improving freight transport productivity
14	√ Tourism industry Innovation
15	√ Sewage Innovation - Japan Resource Creation Strategy
16	√ Rail Productivity Revolution - Productivity Improvement by Development of Next Generation Technology
17	√ Traffic Safety Measures Using Big Data
18	√ **Overseas deployment of high-quality infrastructure**
19	√ ICT Revolution of Automotive Industry
20	√ Creating a Weather Business Market

Productivity revolution projects fall into three categories: social, industrial, and future. It covers a wide range of areas such as transportation, real estate, infrastructure, aviation, shipping, tourism, and weather. Projects directly related to the construction sector include infrastructure maintenance revolution, I-construction and overseas deployment of high-quality infrastructure.

4.2 I-construction

In order to cope with the decrease in construction manpower and to extend the construction site's holidays, increased productivity of the construction site is needed. Accordingly, I-construction that utilizes ICT technology in measuring, construction and inspection was promoted in Japan from 2016. The Land, Infrastructure and Transport Ministry carried out about 6.8 billion yen of R&D investment from 1980 about Construction automation, and about 50% of the total investment was concentrated from 2003 to 2007. Five private heavy equipment manufacturers each invest about 2.5 percent of their sales in research and development. The total annual R&D spending of five companies amounts to about 200 billion yen. In April 2016, the Ministry of Land, Infrastructure and Transport announced 15 new standards to support ICT technologies in line with the full implementation of ICT construction. Based on these criteria, ICT technologies were deployed in practice in all construction production processes for survey, measurement, design, construction and inspection. There is no direct Japanese government support system for ICT construction equipment, but it supports small and medium-sized businesses that want to invest in productivity improvement, and ICT construction heavy machinery can be a way to improve productivity. Komatsu, a leading construction heavy equipment company, offers a variety of solutions, including three-dimensional drawing services and construction plan simulation services related to ICT construction heavy machinery.

A negative perception in the construction industry is that the industry does not allow for enough holidays. The Japanese government has banned Sunday's work at the construction site and plans to phase out Saturday's work. It was decided that higher productivity should be

achieved in order to cope with the same amount of construction in a situation where manpower is reduced and holidays are expanded. As a means to secure high productivity, I-construction was implemented using drone and ICT technologies as a result of convergence of research tasks for informatization construction, robots and CIMs that have been carried out since the 1980s. It utilizes ICT in the entire process of measurement, construction and inspection, and simultaneously improves productivity of construction sites, while "Improving level of wages", "Reliable Holiday Guarantee", "Safety sites," and "Activities of women and senior citizens" are implemented. The government is seeking to introduce ICT technology to Construction field other than Earthwork, promote R&D through consortiums, and promote the supply of ICT technologies to local public organizations ordering construction projects.

ICT earthwork is the leading policy and the core of I-Construction. ICT earthwork consists of three categories: measuring using UAV(Drone), construction using ICT heavy equipment, and inspection using CIM platform. In terms of measurement, it used to take a total of eight days, one days to measure the reference point, three days to measure the cross section, and four days of internal work such as survey and cleanup. However, for measurements using UAVs (drone), The results were obtained to take a total of 4 days. by 1day of the reference point measurements, 1 day of UAV measurements, and 2 days of internal work such as survey and cleanup. In addition, ICT heavy equipment increased the construction volume per day by 1.5 times (based on roadwork) compared to the conventional construction method, and since there is no need for auxiliary work around heavy equipment or installation of safety signs, the workers were reduced by one-third. The field of inspection is related to GNSS and CIM R&D. When the inspection was carried out with manpower, 10 sections of the previous 2 km were measured and took 10 days. However, when measuring with a GNSS-rover, productivity was improved that it

took two days Also, 50 reports were needed per 2km. However, through the three-dimensional data integration it was reduced to only one page report.

Chapter 5: Status of Promotion for 4th Industrial Revolution in Korea

5.1 Government Policy Directions

Currently, the Korean government is pushing for the 4th industrial revolution through a comprehensive policy that closely links each sector to change all sectors of social institutions, the industrial economy and science and technology.

Propulsion direction can be divided into three main categories. First is the intelligent innovation of industrial services. This means upgrading major industries through intelligentization and creating new services. Secondly, it is the improvement of social institutions to proactively respond to future social changes. This means more education for convergence and support for job transfers and securing social safety net. Finally, it is strengthening the foundation of science and technology for industrial innovation. This means establishing hyper-connected networks, securing high-quality data, and improving core technology levels.

The 4th Industrial Revolution is a hyper-connected, intelligent revolution that is triggered by digital technologies such as artificial intelligence and big data, and it causes innovative changes not only in industries but also in national systems, society, and life. As a result, advanced countries recognize the fourth industrial revolution as a core task of growing

innovation and solving social problems, and are actively pursuing to develop intelligence together. The following table shows the fourth industrial revolution response strategies of advanced countries.

Item	USA	Germany	Japan	China
Major Policy	・AI R&D Plan (’16.10) ・AI future preparation ('16.11) ・AI, Automation and Economics ('16.12)	・High-Technology Strategy ('10.7) ・Industry 4.0 ('11.4) ・Platform Industries4.0 ('15.4)	・SuperSmart Society Strategy ('16.1) ・AI Industrialized Roadmap ('16.11) ・New industrial structure vision ('17.5)	・AI 3 action plan ('16.5) ・Next generation AI development plan ('17.7)
Objective	・Secure competitive edge in AI field ・Strengthen social benefits	・Response to digital economic changes ・Leading Smart Factory	・Innovation in all fields ・Solving economic and social problems	・AI next generation growth engine ・Solving economic and social problems
Main contents	・Provide AI R&D Strategic Direction (Investment, Safety and Security, Data, Human Resource Promotion, Public Project, etc.) ・Suggests policy directions for reforming education and employment structure and strengthening social safety net	・Promote global standardization ・R&D Support ・Improved IT infrastructure security ・Introduction of new training methods for human resources ・Implementation in parallel with the Labor 4.0 Policy - Corporate-union dialogue, market economy coordination, etc.	・Selecting the 4 strategic areas (Movement, production and purchase, health, life) ・Strengthen common base (Data, Regulatory, R&D, Security, talent, employment, social security, etc)	・Guide of artificial intelligence ・Established AI National Laboratory ・Industry Smart (Manufacturing, agriculture, finance, logistics, etc) ・Building a Smart Society (Medical, Health/Handway, Traffic, Environmental protection, safety, ・Establish legal and ethical systems for artificial intelligence

Related Organinzation	Office of Science and Technology Policy (OSTP) under the White House	Participation of major companies, research institutes and governments	Promoting cooperation with ministries led by the Prime Minister's Office	·National Development and Reform Committee

Accordingly, Korea is also implementing a comprehensive plan for social safety network, along with the establishment of a comprehensive system for promoting core technologies R&D, data acquisition, human resources development and expansion of industrial societies. Currently, Korea's situation has succeeded in industrializing with capital input choices and concentration in terms of growth, but it faces a dual crisis of declining productivity and poor quality of life for the people. In addition, despite the world's top-class networks, which are the basis of the fourth industrial revolution, the core technological competitiveness that will lead to a revolution in the economy and society as a whole is inadequate. Despite a strong manufacturing base centered on major industries, innovation centered on small and medium-sized businesses in the intelligent field is still limited. Although we have expanded excellent human resources, we are not prepared for counter-functional responses such as cyber threats due to a lack of key human resources based on future demand and insufficient preparation for job change response.

Accordingly, the Korean government has proposed four major initiatives linking science and technology, industrial economy and social infrastructure to realize the fourth industrial revolution. First, the innovation across the entire industry, is starting to realize the potential of the 4th Industrial Revolution, creating new industries and jobs. Second, to secure the technological competitiveness of the world's top leaders and create new growth engines based on R&D, the entire national R&D system was reorganized. Third, focus on creating a sustainable industrial infrastructure ecosystem so that small and medium-sized businesses in the field of

intelligence can emerge as the driving force behind the fourth industrial revolution. Fourth, strengthen support for growth of key outstanding human resources and job security in response to future job changes and establish cyber safety net and human-centered ethics system.

5.2 Government Policy Objectives

Let's take a look at the government's 4th industrial revolution task related to construction. The government is planning to foster Drone industries as new growth engines to secure competitiveness (the 7th-largest technology competitiveness in the world), which is still in its early stage. It is planning to develop convergence-type practical technologies such as flight stability, long-term flight and onboard equipment early and to develop traffic management systems(~2021), future self-driving aircraft(~2022) and GPS system(~2022). It also plans to expand infrastructure such as drone flight test sites and national flight test stations by location and push for the readjustment of related to Law Acts, including a special approval system for night flights, public interest purpose and emergency purpose drones.

In the disaster response sector, the government plans to minimize the public's damages by establishing a smart disaster response system that anticipates abnormal weather conditions and disasters in advance and proactively responds to them. It is going to establish a small early warning system and a disaster prediction alarm system for responding to disasters in order to proactively respond to disasters, expand its observation network for disaster response such as typhoons, and improve accuracy of prediction of disasters.

And the government is going to increase productivity and safety by establishing a smart construction system that combines big data and virtual reality(VR) technologies into construction production processes. To this end, the government is pushing for cutting-edge design, switching the construction system and developing technologies to promote intelligent construction equipment, including three-dimensional virtual design and construction, automatic modular construction, and communication and collaboration systems between construction equipment. In addition, the government is promoting to establish a smart construction foundation by preparing criteria(Modeling standards, guidelines, design guidelines, etc.) for applying infrastructure three-dimensional design(BIM) and to make the BIM application mandatory for road projects worth more than 50 billion won.

In the environment sector, the government will create a new industry to cope with environmental pollution and climate change and realize clean countries by providing fine dust forecast and smart water and water supply systems in response to fine dust and water pollution. To cope with rising operating costs of water and sewerage facilities, the government plans to improve operational efficiency and quality by building a smart future system that incorporates intelligent technologies. In addition, it is planning to optimize operation of sewage facilities such as optimal drug injection and energy use based on IoT-based measurement data and is currently establishing IoT-based real-time water usage and water quality measurement system to improve efficiency and reliability of operation of water supply facilities.

In the field of safety provision, it is leading smart disaster safety industry market by minimizing accident prevention and damage through intelligent systems such as IoT facility maintenance, intelligent CCTV, and marine smart navigation. It is currently developing IoT maintenance system that supports initial management(Warning, Traffic control, etc.) and

structural impact analysis (Durability, etc.) for abnormal behavior of old facilities(Bridge, Tunnel, Dam, etc.). Based on IoT sensors and Deep learning, it will be developed an abnormal behavior detection and prediction system such as deformation and displacement of facilities and is currently promoting pilot operation on aging facilities. In addition, the "Basic Act on Management of Sustainable Infrastructure" is being enacted for preemptive and systematic responses to the aging of major facilities such as Tunnels, Bridges and Dams.

In addition, AI and big data-based risk detection and intelligent decision support system are being developed in place to reduce earthquake damage. It is planning to develop low-cost sensors and mobile-based seismic detection devices and apply technologies that automate secondary damage prevention through extracting and analyzing big data-based risk zones.

For cases of disaster, AI-type disaster response standard platform is being developed that supports real-time decision making and situation determination of disaster control towers in the event of a disaster. It will be intergrated past disaster information, intelligent CCTVs and sensors, satellites, and SNS, In order to minimize disaster response failures, the government plans to spread the information to the public through training to secure countries after developing a standard platform based on AI that expresses key situation situations.

As such, the private sector should lead the efforts in implementing a pan-national response system through cooperation between the public and private sectors. A committee called “The 4th Industrial Revolution Committee” is formed to induce cross-ministerial policy coordination and social consensus to promote implementation of national policy directions in response to the 4th industrial revolution. And government departments prepare detailed implementation strategies for key tasks and implementing and managing each project. The Ministry of Science and Technology, which is the general manager of the 4th Industrial

Revolution Committee, is playing a role of general support for the 4th Industrial Revolution Committee by analyzing issues related to the 4th industrial revolution, drawing key tasks, and preparing policy alternatives.

5.3 Expected Effects of Government Policy

According to the government's fourth industrial revolution response plan report, the economic effects of the fourth industrial revolution are expected to generate up to 128 trillion won as of 2022. It is estimated that new sales will increase by 10.5 trillion to 24.1 trillion won, cost savings by 20.7 trillion to 55.4 trillion won, and consumer welfare growth will increase by 19.6 trillion to 48.6 trillion won. In the new sales increase sector include manufacturing robots for industries and FinTech services that prevent financial fraud. And cost savings sector include reduced nursing costs due to diagnosis and treatment efficiency, reduced operating costs of manufacturing facilities, and reduced cost of damage from financial fraud resulting from improved credit risk analysis. Increasing consumer welfare sector include reducing accident rate due to introduction of self-driving cars, solving urban problems such as reduction of traffic congestion caused by expansion of Smart City, and reducing household labor through intelligent smart home. In addition, the expansion of innovative technologies, such as intelligent technologies, is expected to increase employment of related technical and professional workers in the fields in charge of developing and serving related new technologies. And it is expected that jobs such as simple assembly and production workers, telemarketers, and bank teller will be reduced due to intelligent production of production facilities and expansion of FinTech.

Chapter 6: Current Situation and Future Tasks in K-water

6.1 Maintenance Problems of Current Dam Facilities

While numerous information will be generated and shared throughout the construction project and various efforts will be involved to efficiently manage it, the realization of the dam maintenance system is quite difficult. In general, if dam facilities are not properly maintained and repaired from the planning and design stages to the maintenance phase, large and small accidents can occur. As the perception of dam facilities was concentrated on expansion through new construction, it was difficult to expect effective maintenance as investment for maintenance was neglected. However, recently, awareness of the importance of maintenance has been expanded by recognizing problems caused by indifference to maintenance of facilities. Managing the reinforcement or other history of the facility maintenance work is a key issue in the current operational maintenance system. The reality is that the existing maintenance system does not mean more than just information storage and that the information and history obtained during maintenance are not systematically managed. In addition, the existing system provides the DB based on various dam facility information, but the basic information used as a reference during the field survey must be checked against the facilities, because of which reduces the efficiency of the work. As such, it is difficult to ask for precision during field inspection and maintenance time can be extended. Smart digital technology such as IOT is urgently needed to solve various unexpected problems and to secure the convenience and economy of real-time maintenance in order to maintain a safe dam.

6.2 Introduction Status of 4th Industrial Revolution Technologies in K-water

K-water is currently pushing to introduce Smart Safety Management Technology, which is one of the details of construction safety management tasks. It is actively pushing to introduce ICT and IoT-based technologies to the construction site safety management field in order to strengthen management of field risk factors and prevent human error. Therefore, it is currently examining the selection and application of ICT and IoT-based technologies that can be introduced considering the safety management conditions of each department. In addition, K-water is currently pushing with the study on establishing IoT platform for safety management of construction sites. Major tasks include analyzing the cases of K-water construction accident, suggesting improvement of K-water safety management system, and proposing guidelines for IoT platform construction. For example, the introduction of smart safety management technology already applied and implemented, Juam Dam deployed a real-time remote monitoring system for the tunnel construction site. The construction of tunnels is a high-risk type of construction due to 24 consecutive hours of continuous work under poor working conditions such as rapid changes in the dark quality and enclosed space. In addition, safety education is limited as most of the workers are foreigners, and as the site is located at a long distance from the office, it is difficult to manage the site. Accordingly, through the construction of the entire tunnel area wireless, real-time field management model was established, such as workers access control and oxygen and hazardous gas concentration were continuously measured 24 hours in a row. It is also implementing Smart Safety Management by utilizing IoT Helmet at Gunwi Dam. In the case of

Gunwi Dam, the site is far from the office and an IoT helmet was introduced that can be managed on-site at all times in order to overcome physical business restrictions such as limited safety managers. As a result, it is used in various fields such as real-time safety patrol and safety inspection, mock training, civil resource response, and construction promotion status sharing.

6.3 Challenges of Application of 4th Industrial Revolution Technologies in K-water

K-water projects are in great need to incorporate the fourth industrial revolution technologies. However, K-water, a public corporation, needs the government approval first to make use of these technologies. As described in the previous chapter, the Korean government policies promoting the fourth industrial revolution in Korea's construction sector have lagged behind. K-water itself can simply improve the construction process using drones. However, the transition to the 4th Industrial Revolution technologies in Korea is now very slow. The 4th Industrial Revolution is rapidly approaching Korea as ICT technology and various industrial sectors converge. If the construction industry lags behind, the growth of K-water and global competitiveness could be weakened. In the field of water management, K-water is pushing for Smart Water Management Project that combines ICT technologies on its own. The construction industry also needs to invest much more into R&D.. These days, in the social atmosphere, maintenance is more important than construction. As a result, the government or public corporations are planning and pushing for maintenance-oriented policies. But still, improvements in the construction policies and technologies must come before an emphasis on maintenance. Only then, K-water can take a step closer toward global company. K-water needs to establish partnerships in the form of consultative bodies through cooperation not only with K-water but

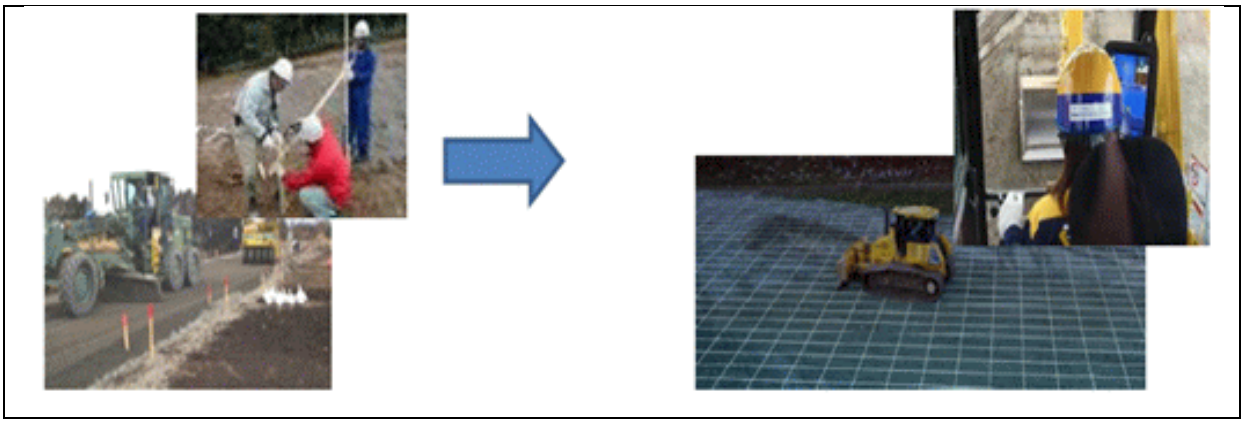
also with research institutes and public-private companies to promote smart construction in the construction sector under the fourth industrial revolution. Since 4th Industrial Revolution Technologies are technologies that combine technical capabilities in various fields, organizations in various fields should pool their resources together.

6.4 The Future Implementation Task for K-water

As described above, currently K-water is facing the challenges related to the fourth industrial revolution technology. Therefore, the company should focus more on applying advanced technologies and ICT training programs to compete with the global company.

In particular, the construction sector requires the experience and knowledge of many experts, and since the cost and time required to complete one construction project is very high, innovation of productivity is more required than other industries. Like the I-construction project in Japan, 4th industrial related projects specific to the construction sector should be promoted. If ICT is utilized in the overall construction program such as survey, construction and inspection, K-water's productivity can be improved while promoting new changes in the construction industry including safety improvements and providing working environments for even female and elderly workers.

In addition, construction using ICT heavy equipments will not only reduce the number of construction days but also save costs with the help of accurate construction capability and reduction of manpower.



Effect of ICT heavy equipment

It is urgent to apply the 4th Industrial Revolution general-purpose technology (IoT, Big Data) to K-water construction and facility maintenance. It needs to:

1. Establish a two-way, interactive safety management beyond the time and space between the supervisor and the construction company.
2. Develop a technology to store video clips required for construction and maintenance from mobile to file and distribute them immediately via SNS.
3. Develop construction and facility maintenance systems using ICT and intelligent CCTV.
4. Develop dam construction and facility maintenance methods using drones.
5. Adopt ICT heavy equipment and establish platforms with technology for 4th Industrial Revolution like Japan.
6. Benchmark advanced countries that already have 4th industrial technologies.

Chapter 7: Conclusion & Recommendation

Currently, the entire world is trying to transform all industries into the Fourth Industrial Revolution era. Accordingly, K-water needs to change to a new paradigm for the fourth industrial era. Rather than a one-time response to the fourth industrial revolution facing it, short-term and long-term responses should be organized exactly as the actual situation of K-water's construction industry. K-water needs to understand exactly what is happening to K-water's construction sector and what problems it has and anticipate potential future problems. For K-water to become a global water company, it must introduce 4th industrial technology for the water resources facilities under construction and management. It is necessary to bring in technologies suitable for efficient and intensive K-water construction projects by introducing 4th industrial technologies. For K-water to successfully lead the fourth industrial revolution related to construction, efficient cooperation between government agencies, research and education institutes and industry is needed. As the fourth industrial revolution improves, It is needed a wide variety of high-quality human resources, so K-water needs to actively foster the converged talent that will lead the fourth industrial revolution. Thus, if K-water introduces and develops technologies that are fused with the 4th Industrial Revolution, it will be a leader not only in Korea but also around the world.

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