THEME 10 DEVELOPMENT OF HUMAN RESOURCES AND TECHNOLOGY: ESTABLISHING SYSTEMS FOR DEVELOPMENT OF HUMAN RESOURCES AND TECHNOLOGY TO MEET CHANGING NEEDS

ABSTRACT

To modernize engineering technology, the Japanese government has invited foreign engineers since 1870 and has promoted technology learning. In addition, the government dispatched students abroad to acquire western technology. Engineers who returned to Japan led public works projects and trained their successors. Currently, the university entrance ratio stands at 49%, and a certain number of civil engineering graduates are entering society. On-the-job training provides opportunities for practical knowledge and skills development at the workplace according to the job position. In addition, off-the-job training is conducted through lectures and seminars, acquisition of technical qualifications, and academic society activities. The Japanese government strives to disseminate its research results to local governments and the private sectors. Government institutions issue guidelines and manuals to disseminate their research and development results. The government should actively use water resources technologies owned by the private sector. The government has been promoting technological development by inviting companies to develop new technologies.

CHAPTER 1 INTRODUCTION

It is necessary to secure and develop diverse human resources in water resources management and develop necessary technologies to respond to changing social conditions and needs.

Water resource management covers a wide range of fields, including legislation, finance, planning, surveys, design, construction, maintenance, and operation. An array of specialties, such as civil engineering, environment, forestry, architecture, machinery, information and communications technology (ICT), law, finance, and economics, are required. Thus, human resources should be secured and trained. The development of technologies and adaptation to changing social conditions and needs is also required. This theme describes the situation of securing human resources and measures for human resource development in Japan. It also introduces the role of governmental organizations in technology development and the measures taken to utilize the technologies developed by the private sector.

Water resources management is closely related to the Sustainable Development Goals (SDGs), and the relationships between human resources and technology and SDGs are shown in the following box.

Relationships between Human Resources and Technology and the SDGs:

To develop abilities of people through human resources development:

SDG 13 “Climate Action” 13.3 “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning”

CHAPTER 2 SECURING AND DEVELOPING HUMAN RESOURCES

2.1 Securing Human Resources

It is necessary to continuously secure the human resources engaged in water resources management by expanding the education system in line with society's development.

Since 1870, the Japanese government has invited foreign engineers to modernize engineering and promote technology learning. Dutch engineers have mainly transferred river technology to the field. Engineers who studied abroad at national expense led public works, taking over the position of foreign engineers. They taught science and engineering and trained their successors.

While the Japanese society developed, the number and quality of human resources remained insufficient, even in the mid-20th century. Japan continued to develop human resources by acquiring, inheriting, and developing advanced technologies learned from Western countries. The country received assistance from developed countries in executing large-scale projects (see boxed article).

The number of students entering universities is 2,556,000 in 2015, and the percentage of students entering universities has increased from 17% in 1970 to 49%. Universities send out many civil engineering graduates annually.

2.2 Development of Human Resources

It is necessary to develop human resources through off-the-job training (off-JT) with on-the-job training (OJT).

(1) Training

In Japan, the capacity development of human resources is practically conducted by accumulating self-development through OJT relevant to the workplace and position held. In addition, off-JT was conducted to promote ability development. Government agencies provide off-JT opportunities.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) administers "the College of Land, Infrastructure, Transport, and Tourism" as a training institute for officials of the national and local governments and other organizations. This college offers many training courses[2], allowing participants to not only acquire knowledge and skills in specialized fields but also gain insights as civil servants, improve administrative skills, and respond to newly emerging administrative issues (e.g., overseas infrastructure business and digital transformation). "The Japan Construction Training Center," an affiliated organization, provides training in different fields of expertise. In addition to officials from local governments and other organizations, the center also accepts engineers from companies.

[2] 120 courses for civil engineering positions. Its lecturers are external experts and senior officials of MLIT.

Large-scale Projects during the Post-war Reconstruction Period: Aichi Irrigation Project

During the 14 years, from 1953 upon restoring sovereignty to 1966, Japan received finance of 7,566 million dollars (at present value) from the World Bank as loans for reconstruction and development of the nation. The loan was invested in 31 large-scale projects including hydropower development, water resources development, highways, and high-speed railways (Shinkansen) construction. "The Aichi Irrigation Project" was one of the 31 projects (Figure 2.1). A dam, 104.5 m in height, was constructed with an effective storage capacity of 68 million m^3. The dam also had irrigation channels consisting of 112 km long main lines and 1,000 km long branch lines to convey water for agricultural, municipal, and industrial uses.

Source: Japan Water Agency Aichi Canal Integrated Management Office

Figure 2.1 Construction with Large Machinery

Japan relied on the technologies of developed countries for the construction of large-scale projects. The planning, design, and construction management of this project were entrusted to American consultants. The consultants proposed a construction method with American-made large pieces of machinery, which contributed to a significant reduction in the construction period and costs. Through this project, more than 500 engineers and local government officials received technical guidance and knowledge transfer. These experiences, along with the increase in public works, contributed to the development of the construction industry and consultants' services.

(2) Lectures, Seminars

The "National Institute for Land and Infrastructure Management (NILIM)" and the "Public Works Research Institute (PWRI), " which are research institutes of the MLIT, hold lectures and seminars. These institutions publish their research results online. Officials of the MLIT report their work results at technical seminars throughout the country.

(3) Acquisition of Technical Qualifications

Acquiring technical qualifications is an effective way to obtain comprehensive knowledge on technical fields of specialty and related social trends to improve communication skills with others clearly and logically. The representative official qualifications certified are professional engineers (PEs), first-class construction management engineers, and first-class architects. In many construction projects and services procured by public authorities, a bid condition is that the person appointed as the managing engineer should have one or more of these qualifications. Thus, it is recommended that engineers and architects acquire these qualifications.

(4) Academic Activities

There are academic societies related to water resources, such as the “Japan Society of Civil Engineers (JSCE),” “Japan Society of Hydrology and Water Resources (JSHWR)” and “Japan Society of Dam Engineers (JSDE).” They discuss issues and present research results related to water. One of the unique activities related to water resources is the "Symposium on River Technology, " which is organized by the River Section[4] of the JSCE Hydraulic Committee. It organizes poster sessions and panel discussions, focusing on river maintenance and management.

2.3 Japan’s Support in Developing Human Resources

> Japan is supporting the capacity development of practitioners and engineers in developing countries by dispatching experts and inviting officials to Japan.

JICA is working to support human resources development for sustainable development by dispatching experts and providing study programs:

- **Dispatching JICA experts:** Experts are assigned to the implementing agency of the counterpart government. They assist in improving the system and organization, and provide capacity building to the staff of the implementing agency with their specialized skills and knowledge.
- **Technical cooperation projects:** These projects are implemented by optimally combining various methods, such as dispatching JICA experts, inviting officials and engineers, and providing the necessary equipment. Capacity building is conducted through daily on-the-job training, seminars, and workshops. In the fields of water resources, 101 projects have been implemented to date.
- **Task-specific training:** JICA mainly invites officials and engineers engaged in practical work in developing countries to contribute to resolving the issues faced, by providing the relevant knowledge and experiences of Japan. Lecturers vary depending on the lecture theme. This helps build human networks of participants from developing countries and Japan.
- **Japanese yen loan:** JICA supports the development of human resources in developing countries. For example, in Mongolia, a study in Japan program is being implemented as part of the “Higher Education Support Program for Engineering” through the “Study Abroad Program of Technical College.”
- **Scholarship Program for Human Resources Development:** The program aims to assist outstanding young officials expected to be future leaders by inviting them as international students in Japanese postgraduate courses. They are expected to be actively involved in the socio-economic development in their countries and expand friendly relations between their countries and Japan.
- **Science and Technology Research Partnership for Sustainable Development (SATREPS):** The Japan Science and Technology Agency (JST), Japan Agency for Medical Research and Development (JIRA), and JICA are collaboratively implementing a research program. Researchers

[4] Proposed by the Water and Disaster Management Bureau of the MLIT and newly established in the Hydraulics Committee of the Japan Society of Civil Engineers.

from Japan and developing countries are engaging in collaborative research to develop human resources and improve research capabilities in both countries (Figure 2.2).

Source: JICA

Figure 2.2 Higher Education Support Program for Engineering in Mongolia

CHAPTER 3 TECHNOLOGY DEVELOPMENT

3.1 Roles of Government Agencies

> The national government should lead technology development on themes that meet social needs. It should also disseminate the technology developed to local governments and the private sector.

The NILIM, PWRI, and the MLIT have shared the results of their research and development activities by publishing guidelines and manuals. The MLIT is revising the Technical Criteria for River Works to reflect technological trends. The criteria establish standards for the plan, design, and maintenance of river works.

The MLIT is leading technology development by setting themes through industry-government-academia collaboration to meet social needs. The roller-compacted dam concrete (RCD) method is a featured example of a technology developed. This method allows the effective use of large machinery in concrete dams and contributes to reducing construction costs. The RCD construction method6 was developed based on the results of studies conducted by a researcher group. It was established in 1973 under the initiative of the Ministry of Construction (currently MLIT) and consisted of members from companies in various fields, government, and academia. After the trial construction of cofferdams by the RCD in 1976, the RCD method was refined with a series of improvements accumulated through applications (Figure 3.1). This method was adopted for projects in Laos and China.

3.2 Utilization of Private Sector Technologies

> The government should promote the development of technologies by the private sector.

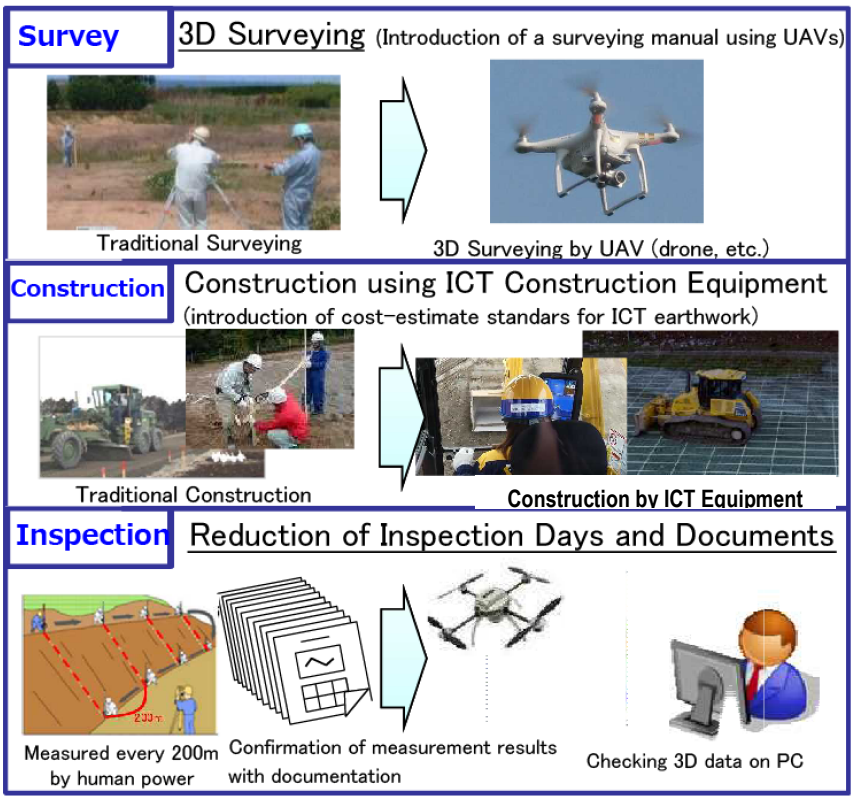
The government can encourage the private sector to invest in research and development by inviting them to research programs, changing bidding systems, and issuing certificates.

Source: Japan Dam Engineering Center

Figure 3.1 RCD Method (Yunishigawa Dam)

(1) I-Construction: Japan is currently experiencing a serious shortage of workers in the construction industry, owing to the aging workforce and stagnation in the employment of the younger generation. The government is actively working on a project called i-Construction, which aims to boost productivity in all aspects of construction by 1) fully utilizing ICT, 2) standardizing specifications, and 3) distributing the timing and load of construction more evenly throughout the year. A consortium comprising industry, government, and academia promotes projects that innovate new technologies or

require collaboration among companies (Figure 3.2).



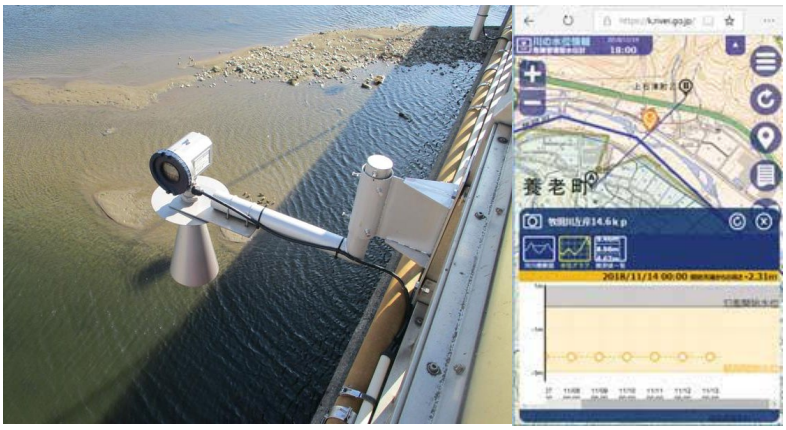
Source: MLIT Website

Figure 3.2 Improvement of Productivity with i-Construction

(2) Public Invitation for Research and Development in River Works Technology: This system was established to research and develop (R&D) river works technology. Themes are selected by inviting proposals from universities, public corporations, and companies. An evaluation committee consisting of experts examines and suggests entrusting R&D to certain organizations. For example, the invitation theme of FY2021 was "Development of evaluation technologies that contribute to strengthening structures of river levees against overflow." This theme aims to cope with large-scale floods that have frequently occurred in recent years.

(3) Innovative River Management Project: The MLIT launched this program in 2016 to develop products that contribute to river and disaster management, in a short period, utilizing advanced technologies. It is promoted through "open innovation," which combines the elemental technologies of companies that own know-how that meets the specifications7 required by the government. For example, a development team formed by a water level gauge manufacturer and a telecommunication company was engaged in developing the "risk-management type water level gauge." Another team formed by a camera manufacturer and an IT vendor was engaged in developing8 the "simple river monitoring camera." The two teams completed product development in 2017, one year after the commencement of development. They are currently in the implementation phase9. By the first half of 2020, approximately 8,800 risk management type water level gauges and 3,700 simple river monitoring cameras were installed (Figure 3.3). The project is now developing "all-weather drones," "land and underwater laser

drones," and "full automated and manpower-saving flow observation equipment."



Source: Foundation of River and Basin Integrated Communications

Figure 3.3 Risk Management Type Water Level Gauge

(4) Issuing verification certificates for new construction technology: Public service corporations, under the MLIT administration, issue verification certificates for new construction technologies developed in the private sector. Public-service corporations also support the dissemination of new technologies. A web system is operated to provide reference information for new technologies.

(5) Bidding system: From the quality assurance and improvement perspective, the comprehensive bid evaluation method requires bidders to submit their technical proposals. This bid evaluation method has become the standard for contracts of construction and services procured by government offices in Japan. Therefore, each company conducts its own research and development.

CHAPTER 4 LESSONS LEARNED

(1) **To continuously secure human resources to manage water resources, the education system should be expanded in line with the development of society.** Various human resources with different specialties are required to manage water resources. The number of personnel need to increase with progress in infrastructure development. To meet these requirements, it is necessary to develop and successfully implement technologies transferred from developed countries and steadily expand the skills of human resources. It is also necessary to establish an education system to support technology and human networks.

(2) **To develop skills by broadening the knowledge of human resources, off-JT and OJT should be positioned as the core for capacity development in water resource management.** It is effective in providing various opportunities and encouraging off-JT. The utilization of training programs would also be helpful.

(3) **To transfer technology to domestic administrators and engineers, financing from development agencies may provide good opportunities.** After World War II, Japan utilized loans from the World Bank for large-scale development projects. Western consultants were engaged as per the loan conditions of the World Bank. Japan utilized the opportunity to acquire knowledge and the latest technology to organize and manage large-scale projects.

(4) **To meet social needs, the national government should lead technology development on the themes needed.** The national government takes the initiative to promote large-scale technology development that meets social needs and requires cooperation among the government, industry, and academia..

(5) **The national government should strive for the dissemination of research results.** It is important to establish unified technical standards that meet national requirements and share these standards among the parties concerned to ensure the quality of water resource management.

(6) **The government can encourage the private sector to invest in research and development.** The Japanese government uses advanced technologies, including those from different fields, to rationalize water resource management through inviting research programs and technical proposal for bidding.