ICT-Based Efficient Maintenance Management Service Works for Waterworks Facilities

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Abstract

Maintenance management services for waterworks facilities include facility monitoring, periodical inspection, and adequate facilities management. Waterworks facilities are mainly composed of water intake plant, drinking water treatment plant, and water transmission and distribution plants. There are many waterworks facilities and managing information makes maintenance management work challenging. Meiden's cloud service, Aqua Smart Cloud (ASC) offers many useful functions such as wide-area monitoring service and facilities management service. The ASC supports efficient maintenance management service works for waterworks facilities. The wide-area monitoring service menu makes it possible to perform remote monitoring of plant facilities located inside and outside the plant in a batch mode. With its function of the Social Networking Service (SNS), information can be easily shared among distant personnel offsite.

The facilities management service menu function, it can centrally manage plant facility data, inspection result, and related documents. Since such data can be grasped at various sites by smart devices like smartphones and tablet PCs, the ASC and smart devices can contribute to prompt information sharing and labor-saving.

1 Preface

When operating waterworks facilities, it is necessary to make following maintenance work such as: "monitor whether the waterworks facilities are functioning properly", "check whether there are any abnormalities in the waterworks facilities through regular inspections", and "organize/update specifications and service life data and properly manage waterworks facilities". The waterworks facilities consist of a water intake plant, a water purification plant, and water transmission and distribution plants. There are many waterworks facilities and managing data information makes maintenance management work challenging. These waterworks facilities have many facilities and related information, making maintenance difficult.

Based on our 40 years of experience and achievements in the facilities management service of water supply facilities, we are working to improve the efficiency of maintenance management service works by incorporating Information and Communication Technology (ICT). This paper describes the functions of our cloud service, Aqua Smart Cloud (ASC), and shows a case study of ICT-based efficient maintenance management service work for waterworks facilities.

2 Introduction of ASC Functions

2.1 Wide Area Remote Monitoring Service

This service enables has a Social Networking Service (SNS) function which centralizes remote monitoring of the current status of the operating conditions of facilities, such as water intake plants, water purification plants, and water transmission and distribution plants. By using the wide-area monitoring service, it is possible to flexibly deal with system scale-down and consolidation. This works in the event that facilities and equipment in other servicing areas are consolidated. Fig. 1 shows a display example of the wide-area monitoring service screen. The status of the operating conditions of facilities and equipment can be monitored, and data lists such as operation trend graphs and alarm setting values can be checked. It can also display and out-

put form data such as daily, monthly, and annual reports. Each data can be checked at any time and place by using not only the central monitoring system but also smartphones and tablet PCs. The SNS function enables smooth information sharing among people working at distant job sites, including communication during regular times and in the event of an emergency.

Fig. 2 shows the system configuration of the wide-area monitoring service. By distributing the data centers at three bases in Japan, we built a resilient natural disaster system. Communication between each facility and equipment to the data center is a closed network, and data communication between the data center and various general-purpose smart devices is authenticated and encrypted to ensure security.

Fig. 1 Display Example of Wide-Area Monitoring Service Screen

It is possible to monitor the current status of the waterworks facilities and examine the operation trend graphs and list of alert setup values data.

2.2 Facilities Management Service

This is a service that can centrally manage information, inspection results, and related documents. Fig. 3 shows a display example of the facilities management service screen. Facilities man-

Fig. 3 Display Example of Facilities Management Service Screen

The facilities management service comes with the features of a facility ledger, facility history management, and inspection records.

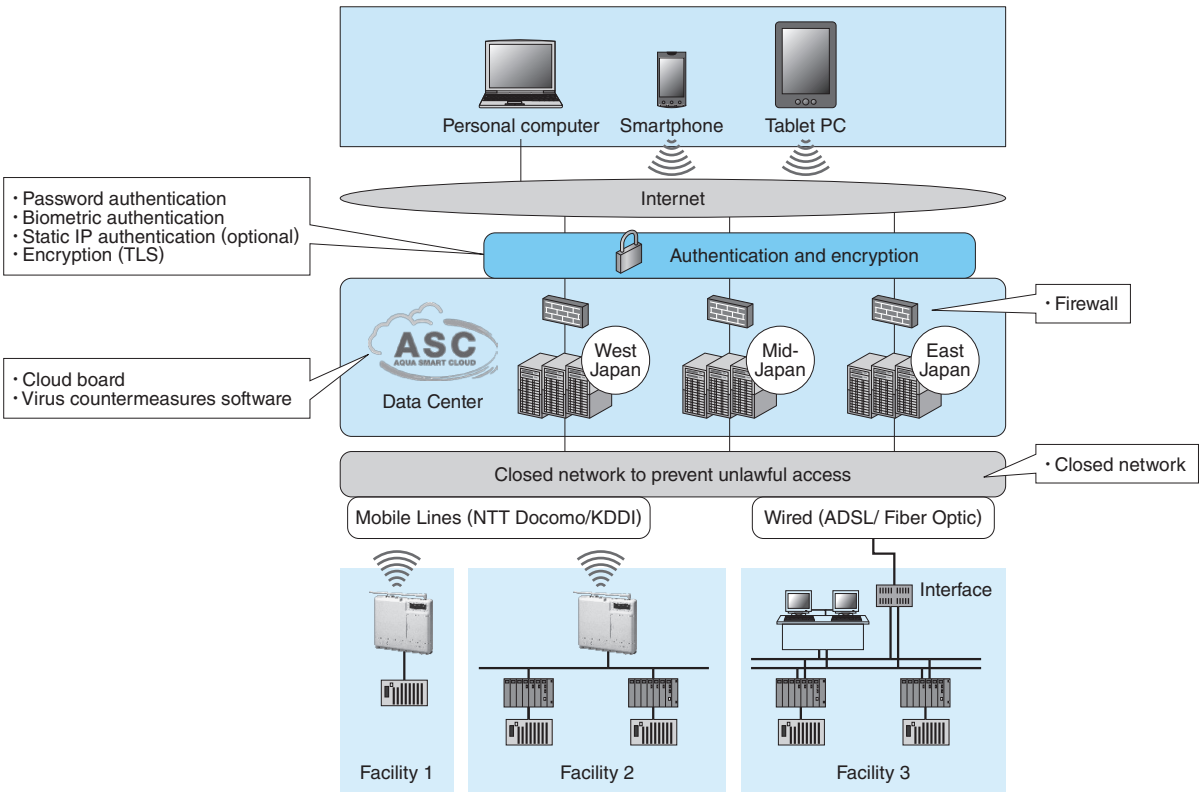


Fig. 2 System Configuration of Wide-Area Monitoring Service

Data centers are distributed to three bases in Japan. The system is built as a natural disaster resilient system. The data communication is a closed network and the security measures such as authentication and encryption are taken.

agement services can be broadly divided into three functions: facility ledger, facility history management, and inspection records. The facility ledger function allows users to register and refer to photos, names, specifications, suppliers, delivered fiscal years, and delivery sites of registered facilities. Fig. 4 shows a display example of the facility history data management screen. The facility history data management function makes it possible to manage the history of facility equipment failures, inspections, and repairs, and register and refer to related documents. Fig. 5 shows a display example of an inspection records screen. Inspection results can be input and recorded directly into the system from the site using a tablet terminal. In addition, the validity of the data to be input can be checked by referring to the values, reference values, input ranges, and thresholds that have been formerly input.

2.3 Asset Management Service

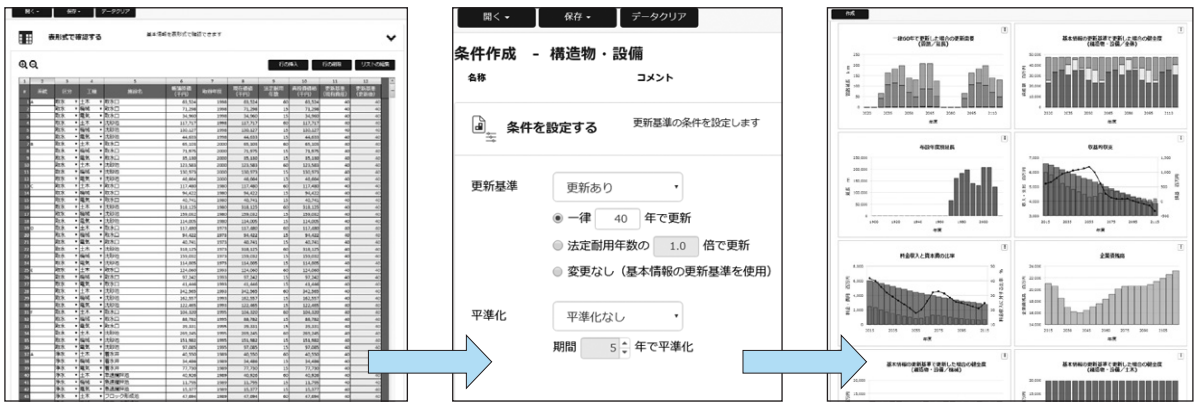
A service that supports the facility owner in making investment plans and renewal plans for waterworks facilities, it is possible to calculate the replacement demand and soundness of facilities and equipment structures and equipment, and to perform financial simulations that consider the replacement demand. Fig. 6 shows a display exam-

Fig. 4 Display Example of Facility History Data Management Screen

It is possible to make facility history management such as facility failures, inspections, and repairs. Registering or referring to related documents.

Fig. 5 Display Example of Inspection Records Screen

Inspection results can be input and recorded directly into the ASC System from the site using a tablet PC or other smart device.



(a) Establishment of the basic information (b) Conditional setting (c) Simulation

Fig. 6 Display Example of Simulation Screen on Asset Management Service

By inputting basic information such as the year of delivery and acquisition cost of the facility equipment, and setting conditions such as deciding factors for renewal, the calculation results are output.

ple of a simulation screen on an asset management service. By inputting basic information such as the year of delivery, acquisition price of the facilities and equipment, and setting conditions such as renewal criteria, the calculation results are then output. Calculation results can be saved in the cloud, and various cases can be simulated by setting detailed conditions and comparing then with other conditions.

3 Example of Efficiency Improvement of Maintenance Management Works Using ASC

3.1 Wide-Area Remote Monitoring as Result of Consolidation of Waterworks Facilities

This section introduces an example of intermunicipal cooperation and consolidation (horizontal integration). The water facilities once owned and operated by multiple municipal water supply utilities have been consolidated and the water services are expanded through water partnerships, both public and private. Prior to the consolidation, operation and management personnel were stationed at each municipal water supply facility to operate the facility equipment. The reconstruction of wide-area water supply facilities is currently underway by suspending the water purification function of some aging and relatively small-scale water purification plants and turning them into water distribution plants. By using ASC's wide-area monitoring service, the status of the operating conditions of equipment installed at water distribution plants can be remotely monitored from manned facilities such as major water purification plants. As a result, unmanned operation of facilities and equipment that have been turned into water distribution stations has been realized.

3.2 Emergency Information Sharing Using SNS Functions

With the use of SNS functions for the wide-area remote monitoring service, information sharing is realized with maintenance management sites located in many places. Fig. 7 shows a display example of an information sharing screen with a maintenance management service site by using the SNS function. Even in the case of natural disasters such as earthquakes and heavy rainfalls, information sharing about facility conditions can be smoothly realized among the notified registered personnel. In such a case, an emergency response task force

Fig. 7 Display Example of Information Sharing Screen with Maintenance Management Service Site by Using SNS Function

Even in the event of a natural disaster such as an earthquake or heavy rain, information about the operating conditions of the waterworks facilities can be shared smoothly among the related people.

can take prompt actions, such as procuring materials and goods in shortage or dispatching a group of people to help the damaged sites.

3.3 Efficient Study on Renovation Using Facility Ledger Functions

For past reasons such as a "Paper-based document system being used" or "Electric document data stored but document formats are different", it was difficult in many cases to refer to information relating to waterworks facilities. If facility ledger functions of the facilities management service are used, however, the information access becomes easier in the unified format. At any time, the details such as facility names, specifications, suppliers, installed places, supplied fiscal years, can be referred. Based on information of equipment specifications, supplied fiscal year, lifetime, and history of malfunction, planning for an overhaul or facility renovation can be planned and drafted effectively. If there should be a report from a supplier about the possibility of a malfunction in a product of the same lot, it is possible to get information about an installed place of the problem equipment in a batch mode and a rapid action for replacement can be taken. The facility ledger function makes it possible to register actual photos of the plant facilities. Fig. 8 shows a display example of actual photos for waterworks facilities. When the name of facility equipment and actual photo are known, it is possi-

Fig. 8 Display Example of Actual Photos for Waterworks Facilities

The names of the facilities and the actual photos can be referred.

ble to reduce the wrong recognition of equipment that is the target of replacement or repair. This method is effective in the prevention of human errors.

3.4 Improving Efficiency of Inspection Patrols Using Inspection Recording Function

To keep the facility equipment of the waterworks facilities running in a normal state, regular inspection of the facility equipment is necessary. When inspections and records of facilities and equipment were performed on paper documents, the number of documents increased, and it took time to access and refer to past inspection records. The inspection record function of the facilities management service menu makes it easy to refer to past inspection records, and since these digital documents can be stored in the cloud, paper consumption can be greatly reduced. The system also has a function for registering and referencing documents and videos. The inspection of facility equipment includes maintenance such as calibrating water quality instruments and repairing leaks in the valves of which some methods are complicated. Fig. 9 shows the inspection patrol scene and inspecting members refere to the inspection method video. By recording videos of proper maintenance methods for facility equipment in advance and referring to such video clips as on-site video manuals, it is possible to carry out appropriate maintenance regardless of the level of experience. Not only for inspection patrols, but also for other operations of the facilities, the same method is used for passing the facility maintenance skills onto the next-generation.

3.5 Drinking Water Treatment Plant Inspection Tour Using Smart Device with Augmented Reality (AR) App

The ASC assists the inspection tour of the

Fig. 9 Inspection Patrol Scene and Inspecting Members Refer to Inspection Method Video

The video manual may be referred to and perform appropriate maintenance work regardless of level of experience.

Fig. 10 Scene of Drinking Water Treatment Plant Inspection Tour with Smart Device with AR Technology

When a tablet PC front camera is pointed at the installed information panel during a plant inspection tour, an explanation with facility name and its role appeares.

drinking water treatment plant. The visiting members use the smart device with an AR app. Information boards with a Japanese cartoon-like character (character panels) are installed at some designated facilities such as sedimentation tanks and filtration tanks in the drinking water treatment plant. When the tablet PC with front camera is pointed at the panel as AR marker, the name of the facility and an explanation of its role appears on the device as an augmented experience (text) on the recognized equipment image information. Fig. 10 shows a scene of a drinking water treatment plant inspection tour with a smart device with AR technology. The visitors

use the smart device with an AR app. By comparing the actual equipment with AR's briefing on its role, visitors can deepen their understanding of drinking water treatment.

4 Postscript

As part of the active use of ICT technology, we have applied the ASC, our cloud service for the maintenance management works for waterworks facilities. The ASC has made many maintenance management works more efficient, such as dealing with the consolidation of waterworks facilities during the process of widening the servicing area, responding to emergencies such as natural disasters, study on the renovation of the facilities, and inspecting patrols.

Going forward, by drawing on our long-year experience of facility maintenance services, we will continue to make the best use of ICT technology to further advance facilities maintenance service works.