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Development of a knowledge transfer support system for water treatment technology

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Abstract

The water supply must be safe and sustainable. This requires a regulatory compliance, selection of an optimal water treatment process, timely response to water quality incidents as well as maintaining internal skills and knowledge among utility personnel to keep appropriate operational standards in the long run. Water supply services in Japan face various challenges, including a shrinking revenue base due to a declining population as well as a mass retirement of the baby-boomer generation. The Japan Water Research Center conducted questionnaire surveys and based on our findings developed the 'knowledge transfer support system for water treatment technology' for utilities to maintain internal skills and knowledge in the face of shrinking labour forces in the water sector. The system consists of three components: the database on water treatment technology, learning program on water treatment technology, and the assessment tool for knowledge transfer on water treatment technology.

Key words: database, e-learning, knowledge transfer, water treatment

INTRODUCTION

The water supply must be safe and sustainable. This requires a regulatory compliance, selection of an optimal water treatment process, timely response to water quality incidents as well as maintaining internal skills and knowledge among utility personnel to keep appropriate operational standards in the long run. Water supply services in Japan face various challenges, including a shrinking revenue base due to a declining population and a mass retirement of the baby-boomer generation. As of 2017, the number of people working in the domestic water sector has reduced by approximately 30% compared to 1980, which had the largest number of workers (MHLW n.d.).

How to maintain internal skills and knowledge has been an issue of concern for Japanese water utilities in recent years. The mass retirement of experienced engineers has made it difficult to educate and share their knowledge properly with younger personnel. On the other hand, the technical environment such as Information and Communication Technology (ICT) has advanced rapidly.

This paper discusses a part of a research program conducted by the Japan Water Research Center (JWRC) to develop a support system for utilities to maintain and succeed internal skills and

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knowledge in the face of changing social environment such as population declines as well as advancing technological environment such as ICT. The three-year research program was implemented in collaboration with universities, public water utilities and private corporations, and concluded in September 2018.

MATERIAL AND METHODS

The program targets small and medium scale utilities as they tend to face more difficulties than large utilities in terms of internal knowledge transfer regarding water treatment. The research objective is to develop a system to support knowledge transfer and human resource development using ICT. The tool is called the 'knowledge transfer support system for water treatment technology' and consists of three applications (Japanese version only): a database on water treatment technology, learning program on water treatment technology, and an assessment tool for knowledge transfer on water treatment technology (Figure 1).

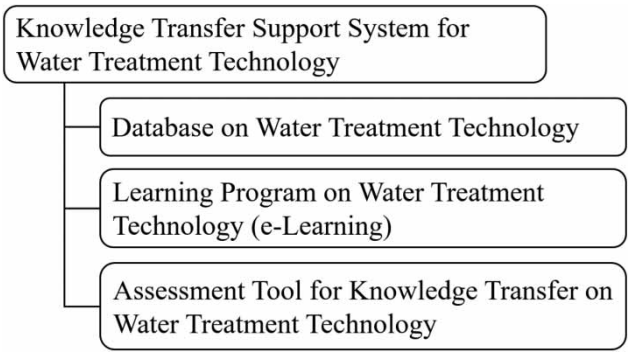

Figure 1 | Overview of the knowledge transfer support system for water treatment technology.

First we sent a questionnaire survey to 952 Japanese utilities with over 20,000 population served to ask about the current status and needs regarding internal knowledge transfer and human resource development. The second questionnaire survey was sent to select utilities that agreed to provide further support for our research, asking about their knowledge required for the operation of water treatment plants and relevant good practices. Further, we visited some of the utilities for in-person meetings to better understand their responses to the surveys.

The survey result allowed us to set basic capabilities of the 'knowledge transfer support system for water treatment technology' as follows.

Database on water treatment technology

This database on the technologies and knowhow regarding water treatment should be a cloud-based database that can be accessed from anywhere with access to the Internet. The database aims to assist knowledge transfer by storing and sharing the information on treatment-related technologies and knowledge specific to individual water treatment plants.

Learning program on water treatment technology

Anyone registered should be able to access this learning program from anywhere, therefore the program should be provided as an e-learning program. This would particularly be helpful for those utilities that face difficulty participating in in-person learning/training programs in remote areas

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because of geographical reasons and/or available human resources. The e-learning program aims to provide general knowledge concerning water treatment process and technologies, and to assist human development at utilities (it is not designed to prepare users to address specific issues and needs at individual water treatment plants because it would be difficult to develop such a tailored e-learning program).

Assessment tool for knowledge transfer on water treatment technology

The assessment tool should be designed to visualize the weak spots of the utility compared to others in terms of internal knowledge transfer to help with their self-assessment.

RESULTS AND DISCUSSION

For the first questionnaire survey conducted in December 2016, we received answers from 603 utilities of the 952 utilities for our 34 questions. Figure 2 shows the answers regarding challenges in knowledge transfer. The most common issue was the 'shortage of young engineers' (50.3%) followed by the 'experiences and knowhow not clearly documented' (46.6%).

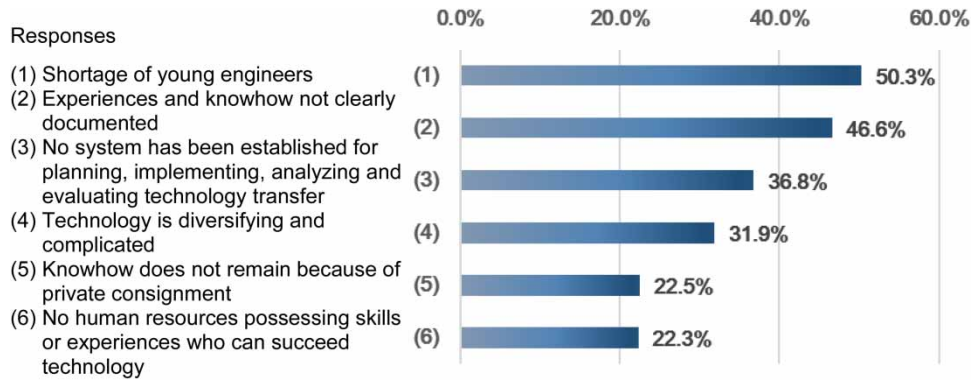

Figure 2 | Questionnaire about issues with technology transfer (multiple selection allowed).

The first questionnaire survey revealed that many utilities have issues and face difficulties with knowledge transfer. This convinced us that there is a need to develop applications to facilitate knowledge transfer and human resource development. In developing the applications, we determined their specifications based on the survey results. The capabilities of each application are presented below.

Database on water treatment technology

By hosting the database on a cloud-based platform, anyone with access to the Internet could acquire information on a wide range of utilities anytime from anywhere. This database is mainly aimed at facilitating knowledge transfer within utilities. Therefore, to make it easy for utilities to accept, we have developed functions and operational rules.

Figure 3 shows an image of accessing the database. As it is a cloud based system, any utility with access to the Internet, regardless of their size, could utilize and accumulate knowhow anytime from anywhere. Users could not only browse the knowhow in the registered order, but also search particular information by typing in keywords.

Initially, 341 cases were available in the database, which were collected by the second questionnaire survey. Figure 4 shows the registered knowhow by classification type and number. The

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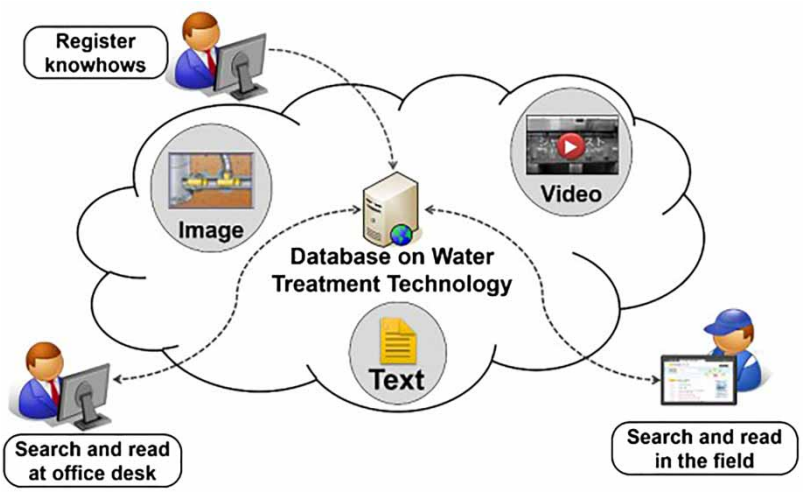

Figure 3 | Image of accessing the database on water treatment technology.

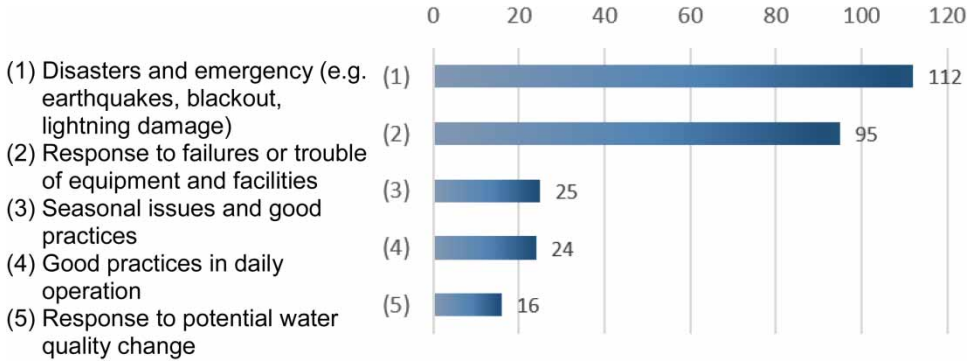

Figure 4 | Top 5 classifications of the registered knowhow (341 cases in total).

knowhow in the database is made anonymous, but those interested could ask registrants for details through JWRC.

We expect the number of available knowhows to increase on a regular basis as more people access and use the database. One option we are now considering to increase the number of knowhow registrations is to invite the system users to provide their knowhow for the database regarding specific themes. The more the database is known and commonly used by water professionals, the more the shared knowhow will help the knowledge transfer in the water sector.

Learning program on water treatment technology

One thing that the first questionnaire survey looked into was which topics would be suitable to learn by e-learning. The result showed a higher educational demand for a 'rapid filtration systems' with a 'coagulation and sedimentation' process for 'those with a less than 3-years' work experience' (Figures 5 and 6).

This program consists of e-learning and a reference information list as shown in the overview of the learning program on water treatment technology in Figure 7. The e-learning offers one learning unit for one water treatment process, and each learning unit comprises a basic course and an advanced course. Currently, we have developed the basic course for the coagulation and sedimentation process, rapid filtration process and disinfection process, based on the survey results. The basic course is designed to help operational beginners to learn about the water quality parameters for water treatment, treatment mechanisms, common chemicals and how to store them safely and hygienically,

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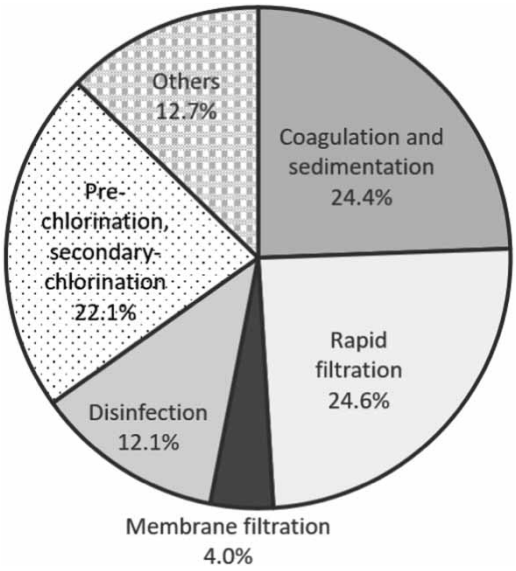

Figure 5 | Questionnaire survey on important water treatment process.

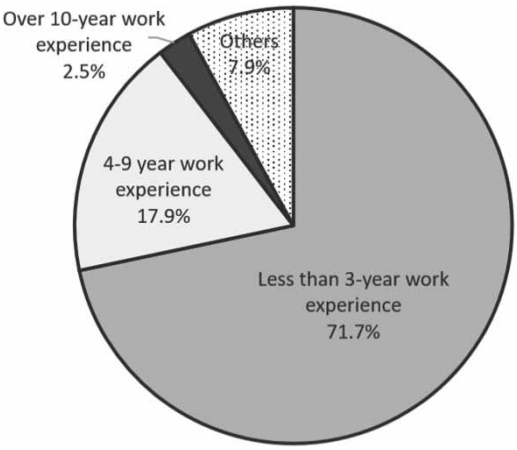

Figure 6 | Questionnaire survey on suitable personnel for e-learning.

facilities and equipment, and basics on their maintenance. All the texts come with a variety of pictures, figures, animations and video clips, which will make the tasks in each unit easier to complete.

The learners need to take an exam at the end of each course. The questions are selected randomly from different categories of topics each time to avoid repetition, and the learners need to choose the best answer from among four choices. When given marks, learners can read related texts to reinforce their memories on what they have learned in that course.

We offer only reference information (e.g. list of related seminars, list of reference material) for some of the learning topics as they are difficult to learn through e-learning (e.g. field operations) or if there are specific learning tools already provided (e.g. certification exams).

E-learning is our answer to the utilities that cannot afford to attend various training programs hosted in remote municipalities.

Assessment tool for knowledge transfer on water treatment technology

This tool assesses the level of knowledge transfer within utilities based on the basic capacity information of user's utility (e.g. size, workforce, facilities) and their current efforts (e.g. development of

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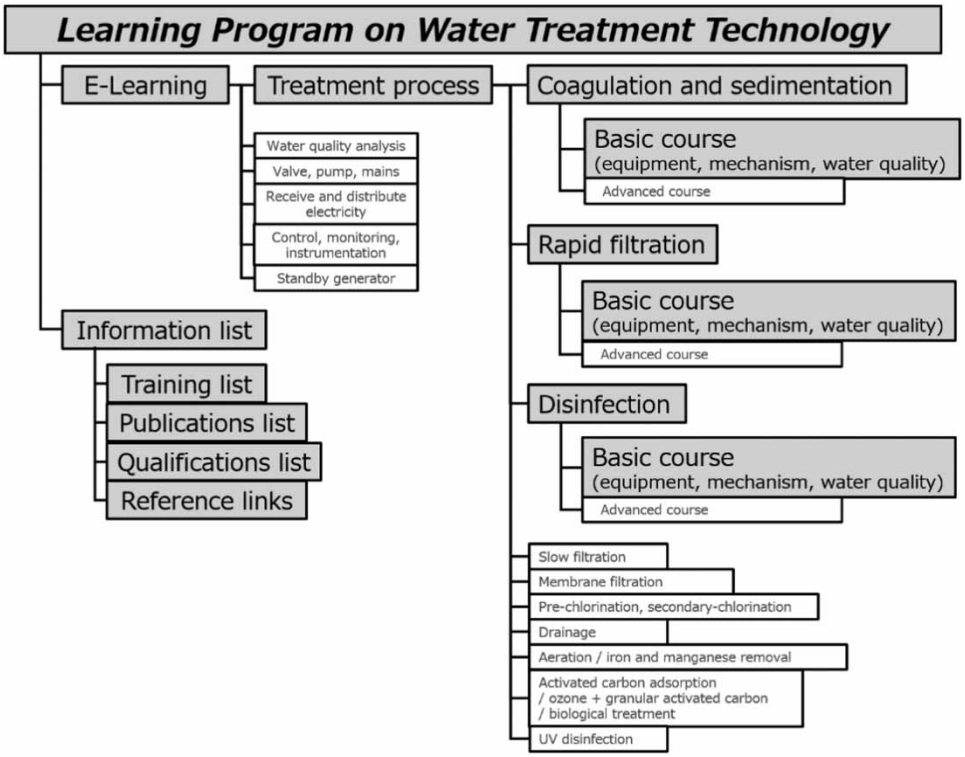

Figure 7 | Overview of the learning program on water treatment technology (grey highlights denote topics that have already been developed as of writing this paper).

relevant manuals). Assessment grades can be obtained rather easily, by the basic capacity information calculated automatically from the statistical data such as the Japan Water Supply Statistics (JWWA 2017) and the efforts information manually typed in. This tool displays the assessment results of the user's utility as a radar chart, total assessment and histogram of each assessment index. It compares their grades with the average of the Japanese utilities and the average of target utilities to compare with and makes a relative assessment. Figure 8 shows an image of an assessment result by the tool. This tool can also make an assessment by narrowing down the utilities to be compared with and by assuming conditions that are anticipated in the future.

With a continuous input from many users of our system, the database on water treatment technology will become more useful for utilities as it will provide more knowhow and examples with which to mitigate or solve their challenges. Also, the e-learning program on water treatment technology is expected to support an efficient human resource development in the water sector by providing an ideal means to enhance knowledge on water treatment at the learner's own desk, whereas the assessment tool for knowledge transfer on water treatment technology can visualize the challenges in knowledge transfer within user's utility, hence giving a motivation to work further on the subject.

CONCLUSIONS

We have developed the knowledge transfer support system for water treatment technology, which consists of three applications: the database on water treatment technology, learning program on water treatment technology, and the assessment tool for knowledge transfer on water treatment technology. We ran its closed beta version from July to October 2018 and the complete version has

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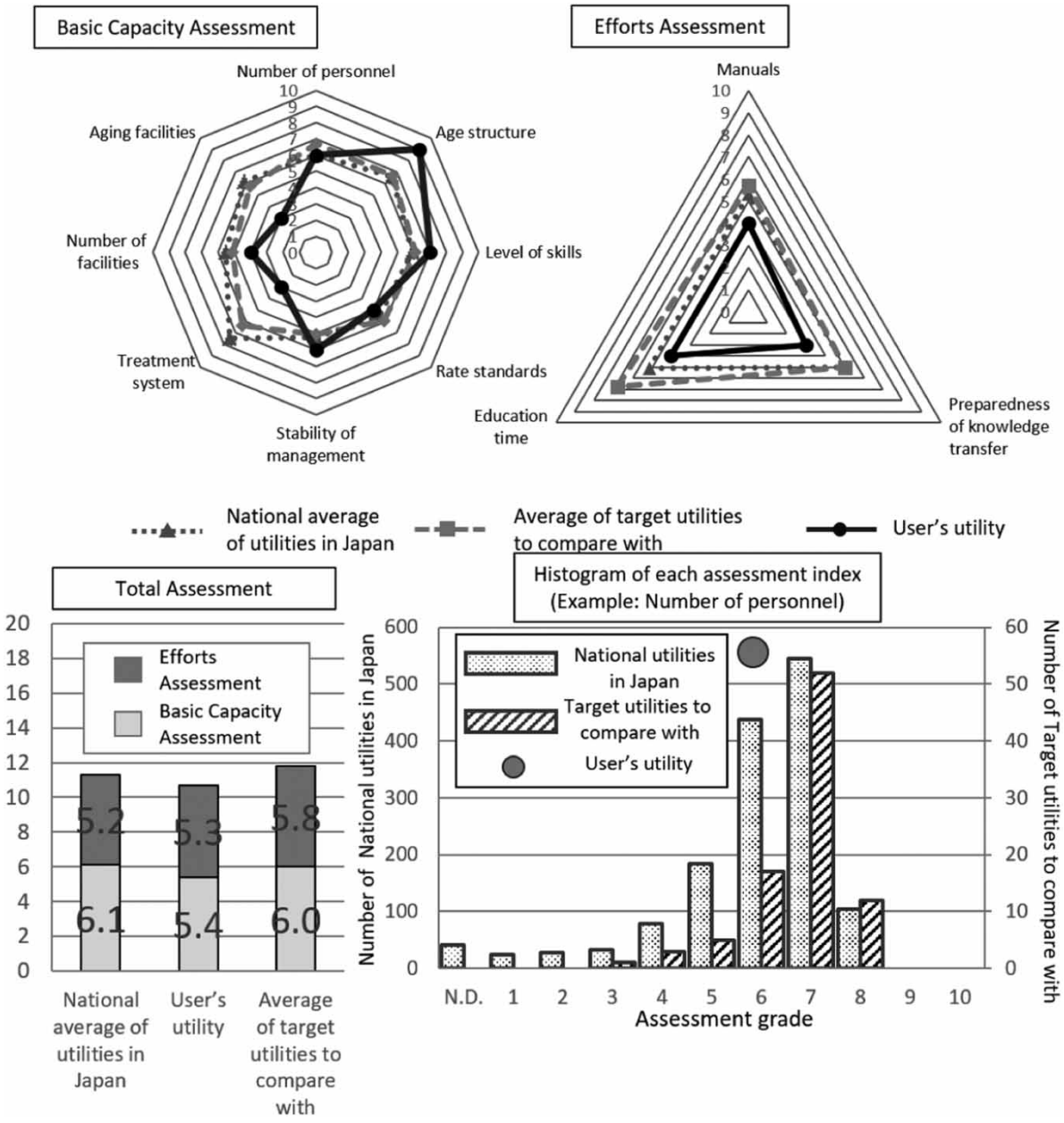

Figure 8 | Image of an assessment result by the assessment tool for knowledge transfer on water treatment technology.

been fully operational since October 2018 on JWRC's website. Currently, another project is going on at JWRC in order to enhance/update the functions/information of the system.

In the coming months and years the system will be equipped with more data and learning courses to enhance its database and e-learning program. We would also evaluate the system's effectiveness in due course.

We expect the knowledge transfer support system for water treatment technology to support knowledge transfer and human resource development within the utility in the face of a shrinking workforce and labour shortage. Also, although the system in only available in Japanese, we hope its existence will be more known outside of Japan so the fact that we have developed this type of system to assist knowledge transfer and human development will provide an example of mitigation strategies for utilities facing a similar challenge in other countries.

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